study of non-point agricultural pollution

MAINE

prepared by:
soil conservation service
u.s. department of agriculture

STUDY OF NON-POINT AGRICULTURAL POLLUTION

SNAP

STATE OF MAINE

Sponsored by:

Maine Soil and Water Conservation Commission
Maine Association of Conservation Districts
Maine Department of Environmental Protection
Maine State Planning Office

Assisted by:

U.S. Department of Agriculture
Agricultural Stabilization and Conservation Service
Farmers Home Administration
Forest Service
Science and Education Administration-Extension
Science and Education Administration-Federal Research
Soil Conservation Service

Under the authority of River Basin Surveys and Investigations, Section 6, Public Law 83-566, 68 Stat. 666 (16 U.S.C. 1006), which provides for cooperative studies among Federal, State, and local governments in appraising water and related land resources.

This study was conducted in compliance with all requirements respecting nondiscrimination which provide that no person in the United States shall, on the ground of race, creed, color, sex, or national origin, be excluded from participation in, be denied benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
USDA Office Building, University of Maine, Orono, Maine 04473

SUBJECT: Study of Non-Point Agricultural Pollution (SNAP)

TO: Concerned Citizens

The use and condition of soil and water affects the lives of every Maine citizen. Financial well-being, recreational opportunities, and the assurance of a good supply of quality food at reasonable prices depend on how the soil and water problems of today are addressed. Money and time have always been in limited supply. Problem solving must be carried out on a priority basis. This Study of Non-Point Agricultural Pollution has been prepared to assist Maine people in directing their money, time, and effort in solving soil and water problems so as to create maximum benefits. The study was conducted under the leadership of Maine Soil and Water Conservation District Supervisors. The recommendations reflect the thinking of these conservation leaders.

The Soil Conservation Service is pleased to have had an opportunity to help in the development of this study. The USDA Soil Conservation Service will use all of its resources to assist Soil and Water Conservation Districts in working with Maine farmers in protecting and improving soil and water resources.

Warwick M. Tinsley, Jr.

Warwick M. Tinsley, Jr.
State Conservationist

ACKNOWLEDGMENTS

The study was endorsed by the following agencies--all members of the statewide USDA 208 Committee--and conducted with the assistance of their personnel:

U. S. Department of Agriculture

Agricultural Stabilization and Conservation Service
Farmers Home Administration
Forest Service
Science and Education Administration - Extension
Science and Education Administration - Federal Research
Soil Conservation Service

Maine Forest Service

University of Maine

Pesticide Control Board

Special recognition is given Maine's 16 Soil and Water Conservation Districts for their leadership and many contributions to this study.

CONTENTS

Soil conservation and clean water to insure the promise of tomorrow.

INTRODUCTION TO STUDY OF NON-POINT AGRICULTURAL POLLUTION

SNAP

The Study of Non-Point Agricultural Pollution (SNAP) was sponsored by the Maine Soil and Water Conservation Commission, the Maine Association of Conservation Districts, the Maine Department of Environmental Protection, and the Maine State Planning Office, and endorsed by Maine's Regional Planning Commissions. The study made it possible for Maine's 16 Soil and Water Conservation Districts to appraise and report individually on the three major non-point sources of agricultural pollution: soil erosion, animal manure, and chemicals. The statewide appraisal summarizes the reports prepared by the Conservation Districts. Copies of individual Soil and Water Conservation District reports may be obtained from District Supervisors (see Appendix C).

In addressing soil erosion and the resulting sediment as an agricultural non-point source of pollution, only fields at least 10 acres in size and used for row crops at least once in the past 5 years were studied. Limited funds and time prevented inventorying fields with less than 10 acres used for row crops. Fields smaller than 10 acres are important to agriculture in Maine, but most of the commercial row crops are grown on larger fields.

SNAP is a unique appraisal in that it is site specific. Rates of soil erosion were determined for each cropland field and identified on aerial photographs. This permits Conservation Districts to direct their limited resources to the worst problem situations on a priority basis. Fields with the highest rates of soil erosion tend to contribute the largest amounts of sediment pollution to surrounding waters.

Animal manure is a major source of non-point agricultural pollution in Maine. This appraisal identified farms with over 10 animal units; their locations are indicated on accompanying maps. The amount of manure produced in a given watershed directly influences the potential for non-point source agricultural pollution. A growing number of farmers have developed manure recycling plans and constructed appropriate handling facilities meeting United States Department of Agriculture Soil Conservation Service Field Office Technical Guide criteria to prevent or limit water pollution. Farms with plans and facilities also have been indicated on the attached maps. To control non-point source agricultural water pollution, Soil and Water Conservation Districts will draw on this information in directing technical assistance to farmers with the largest concentration of animal units adjacent to bodies of water.

Pesticides and chemical fertilizers are essential to the production of food and fiber in Maine. These farm chemicals, however, have been identified as a third major source of agricultural non-point pollution. This appraisal has attempted to identify the types and amounts of agricultural chemicals being used within specific watersheds, based on the types and acres of crops grown. The potential for water pollution is related to the types and acres of crops grown in a specific watershed. This information should provide guidance for future studies designed to specifically identify chemical pollution by monitoring.

The timing and quantity of fertilizer and pesticide use was considered. Also evaluated were sources of spray water, the facilities for mixing pesticides, and chemical container disposal methods.

The development and implementation of complete soil and water conservation plans by farmers is fundamental to solving non-point agricultural pollution problems. Plans should represent each farmer's decisions based upon USDA's Soil Conservation Service (SCS) Field Office Technical Guide criteria for controlling soil erosion, recycling animal manure, and proper use of pesticides and fertilizers.

SUMMARY

This three-part report discusses three sources of agricultural non-point pollution. Part I discusses the causes and effects of soil erosion and possible treatment. Part II discusses animal manure: the amount produced, disposal techniques, and water quality considerations. Part III discusses the use of agricultural chemicals and their impact on water quality.

Sheet and rill erosion on Maine's 302,742 inventoried acres of cropland averages 6.0 tons per acre per year and generates over 1.8 million tons of eroded soil annually. Approximately 15 percent of this eroded soil finds its way into Maine's waters as sediment. The most extensive cropland erosion problems are in the central part of Aroostook County. Nearly all gully erosion is in the eastern, central, and northern parts of Aroostook County. Cropland in the Knox-Lincoln Soil and Water Conservation District has the highest average per acre soil loss rate in the State, although the acreage involved is relatively small.

About 60 percent of the State's cropland needs conservation treatment to reduce soil loss to tolerable levels. Any accelerated conservation program must consider the economic impact on the farmer. Increased technical and financial help are needed to assist farmers in achieving land and water quality goals.

Approximately 2 million tons of animal manure are generated annually by approximately 166,000 animal units in Maine's 16 Soil and Water Conservation Districts. Improper storage of manure during the winter months and during periods when spreading would injure crops or prevent grazing is a major factor contributing to water pollution. Only 60 of 2,802 farms were identified as having animal manure recycling plans and animal manure storage facilities meeting SCS Field Office Technical Guide criteria.

Manure spreading practices and large numbers of livestock with direct access to water bodies were identified as potential sources of pollution on some farms.

Recycling plans are needed for all livestock enterprises to help farmers handle and store manure properly. Additional financial assistance is needed to encourage farmers to build needed manure storage facilities to prevent or reduce pollution of water bodies.

Chemical fertilizers and pesticides are essential in meeting the Nation's current food and fiber needs. Most agricultural operations use such chemicals according to label instructions and only in the amounts needed; however, the amount of toxic material used is increasing.

The potential for misuse and chemical accidents is also increasing. There have been incidents of pollution from agricultural chemicals in most areas of Maine. Problems occur in proportion to intensity of agriculture.

An evaluation of reported fishkills shows most have been caused by improper handling of pesticides. Biological magnification has occurred with some persistent pesticides used in the past. The greatest unknown of chemicals used in modern agriculture is the effect of two or more chemicals reacting together in the environment.

Nitrogen is highly soluble and represents a potential threat to human health in drinking water. Phosphorus contributes most to algae blooms in lakes and ponds and accelerates eutrophication.

Satisfactory methods must be found to properly dispose of pesticide containers and other agricultural waste to prevent contamination.

Economic benefits and environmental costs of using agricultural chemicals should be more thoroughly examined. Information about safe use of pesticides is being offered to the public as it becomes available.

OBJECTIVES AND USES

The overall objective of the Study of Non-Point Agricultural Pollution (SNAP) is to identify the location, extent, and kinds of agricultural practices causing water pollution from sediment, animal manure, and agricultural chemicals. This appraisal will be used by Soil and Water Conservation Districts in setting priorities, carrying out programs to solve worst problems first, and making maximum use of the limited resources of the Districts. It will enable Department of Agriculture agencies--such as the Agricultural Stabilization and Conservation Service (ASCS), Farmers Home Administration (FmHA), Forest Service (FS), Science and Education Administration-Extension (SEA-Extension), Science and Education Administration-Federal Research (SEA-FR), and Soil Conservation Service (SCS)--to adjust and realign their resources so as to insure their use in the most efficient and effective manner. SNAP will provide information helpful to the U. S. Environmental Protection Agency, U.S. Department of the Interior, and other agencies which have environmental, economic, and social responsibilities in Maine.

Public Law 92-500, Section 208, requires assessments of non-point pollution problems. SNAP provides an assessment of soil erosion on cropland, animal manure use and disposal, and chemical use and container disposal, all recognized sources of water pollution in Maine. Designated "208" planning agencies using SNAP will be better informed and better able to develop meaningful plans for solving or controlling these problems.

This study is intended to contribute to three specific objectives:

- To reduce cropland erosion to an average of less than 3 tons of soil lost per acre per year.
- To keep livestock and poultry manures from polluting streams, lakes, and reservoirs.
- To keep agricultural chemicals from polluting surface and ground water.

SNAP contributes to these specific objectives by providing data to define present conditions of cropland erosion, needs for livestock waste control practices, and estimates of agricultural chemical use rates and current methods of disposal of chemical containers.

This study determined the locations of the most serious problem areas.

As in most segments of modern society, technology has made significant changes in Maine's agriculture. Farmers have used their land more intensively as a result of these technological changes. The economics of farming also has strongly influenced farm size and practices. Dairy farmers are growing more corn for silage and grain. Potato farmers are growing more acres of potatoes without benefit of conservation rotations. The use of chemicals in controlling weeds has substantially increased. The continuing growth of mechanization to reduce labor has led to larger and larger pieces of equipment bringing about many changes in field arrangements and cropping systems. The net effect of all these changes has been an increase in soil erosion on many farms in Maine. Farm size probably will increase with further consolidation of fields and will result in increased use of larger equipment, posing additional erosion and sedimentation problems. New pesticides will be developed; the volume used will probably increase. Herd size probably will increase as the result of dairy farm consolidation, thereby expanding problems of handling and storing manures. Care must be taken to insure that Maine's land and water resources are protected.

GOOD QUESTIONS AND PROVEN ANSWERS

Can traditional soil and water conservation programs have a significant beneficial impact on water quality?

Can programs involving the voluntary cooperation of landowners, encouraged by incentive payments, produce land treatment sufficient to improve water quality to the level of present and future water quality standards?

The following answers are summarizations of key points:

... Soils regenerate slowly, but proper cropland management helps.

... While sediment is regarded as a pollutant, other contaminants which attach to sediment particles may cause most of the agricultural pollution. Control of many agricultural pollutants can be achieved through control of sediment. Soluble nitrate nitrogen and some pesticides are exceptions which require special consideration and may not be adequately treated by traditional soil and water conservation practices.

... Storm intensity and duration have a major impact on erosion. As much as half the erosion during 1 year could result from one major storm. Maintaining a complete vegetative surface cover is usually the best means of controlling sheet and rill erosion.

... Not all non-point source pollution is related to agriculture. Other examples include nutrients and bacteria from septic systems and sediment from construction, development, roadways, etc.

... Water quality improvement must be approached by treating the critical areas first. Achieving proper treatment on every acre is a good long-term goal.

... Conservation practices need to be carefully selected for treatment of critical areas contributing to water pollution, depending on individual farm needs. Conservation practices are sometimes referred to as Best Management Practices (BMP's). BMP's may include field borders, crop rotations, grade stabilization structures, diversion ditches, grassed or rock-lined waterways, livestock exclusion, pasture planting, Integrated Pest Management (IPM), proper use and timing of pesticides and fertilizers, sediment control basins, terraces, limited channel protection, tillage methods which increase crop residue and surface roughness, planning assistance, cost-sharing, etc., (see Appendix A).

... Public information on a continuing basis is critical to successful land treatment programs. Landowners and the general public should be kept informed on all phases of the conservation program from planning to implementation.

... Farm operators will readily incorporate land treatment programs into farming operations if the initial cost is not excessive, present or future profit potential is not weakened, and farm work is not unduly complicated.

... Experience of Soil and Water Conservation District Supervisors in Maine has shown when there is sufficient technical and financial assistance available, District programs coordinating all State and Federal resources are effective in achieving protection of land and water from agricultural sources of water pollution.

... A farm conservation plan developed by the operator with qualified technical assistance and approved by the Soil and Water Conservation District is essential. The plan should be simple and deal with specific problems.

... Flexibility in the rate of cost-sharing incentives is desirable with the local Conservation District responsible for setting the cost share rates for individual practices, depending on cost and seriousness of the problem.

I. CROPLAND SOIL EROSION APPRAISAL

Uncontrolled runoff water washes away seed, soil, nutrients, and pesticides.

Spring runoff water pollutes a pond with sediment.

Severe erosion destroyed this potato crop and the field's future productivity.

Up and down hill crop rows help runoff water form gullies.

Magnitude of the Erosion Problem in Maine

Maine has approximately 1.2 million acres of cropland, according to the 1967 Conservation Needs Inventory. Only 25 percent (303,000) of these acres are used for row crops in fields 10 acres or larger. Some of the land is continuously farmed in row crops and on the rest row crops are grown in rotation with grain or hay. Soil losses from sheet and rill erosion vary widely.

In many areas of the State, corn and dry beans are considered important crops. These crops provide little protection against erosion. Often no rotation is used, especially when corn is raised in conjunction with a dairy operation. Some farmers do not have enough suitable land to meet corn production needs and to permit the planting of grain or hay in rotation. Finances restrict most farmers to planting their land to crops which provide the greatest cash returns. The increasing dependence of dairy farmers on silage corn and the increasing market for dry beans means that more land probably will be planted to these crops in the future.

The average annual soil loss rate for Maine's 303,000 acres of cropland (land used for row crops) is 6.0 tons per acre per year (Table 1). Tolerable soil loss for most Maine soils, as established by the Soil Conservation Service (SCS), averages 3 tons per acre per year over the crop rotation. Thus, the average annual soil loss for the State is twice the suggested tolerable limit. This does not include soil loss from gully erosion. On some soils, such as Thorndike, where bedrock is shallow, the tolerable soil loss limit is 2 tons per acre per year. Assuming the soil is 15 inches deep, an erosion rate of 20 tons per acre per year would expose bedrock in about 100 years.

Approximately 128,000 acres of cropland in row crops are under good soil and water conservation management, with soil losses held to tolerable limits. The average soil loss rate on the remaining 175,000 acres in row crops is about 9 tons per acre per year--three times the suggested limit.

About 48 percent of Maine's cropland is within the Central Aroostook Soil and Water Conservation District (S&WCD). These 144,954 acres (fields 10 acres or larger) have an average annual soil loss of 6.9 tons per acre per year and generate an estimated million tons of eroded soil annually. About 69 percent of the Central Aroostook cropland needs conservation treatment. Nearly 24,300 acres of cropland are losing more than 10 tons per acre per year. This acreage is more than the total cropland of Oxford, Cumberland, Waldo, Piscataquis, Franklin, York, Knox, Lincoln, Washington, and Hancock Counties combined.

TABLE 1 - TOTAL SOIL LOSS AND AVERAGE PER ACRE LOSS ON INVENTORIED CROPLAND IN MAINE'S SOIL AND WATER CONSERVATION DISTRICTS

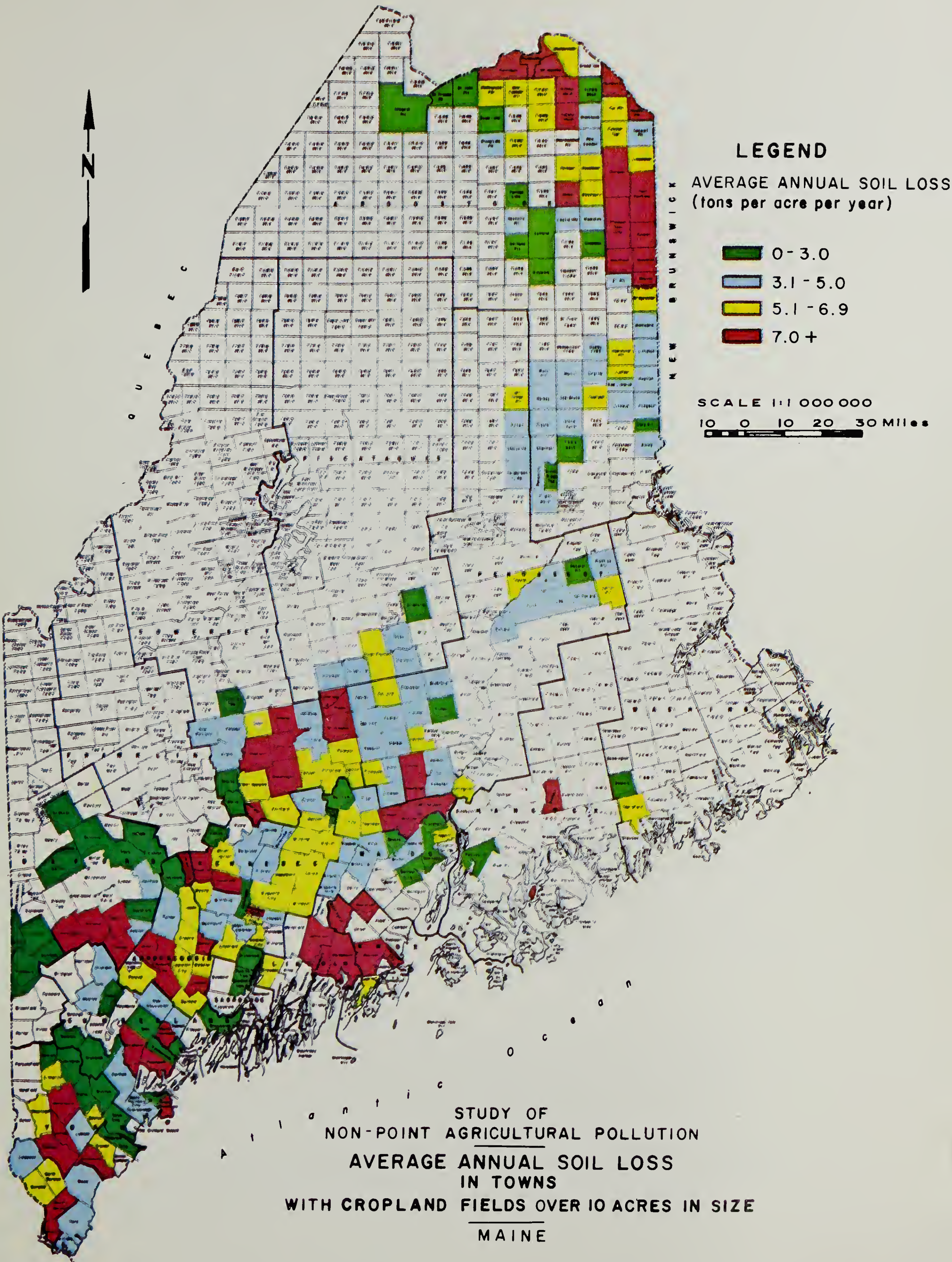
Soil and Water Conservation Districts	Cropland (acres)[1]	Average soil loss (tons per acre per year)[2]	Total average sheet and rill erosion (tons per year)
Central Aroostook	144,954	6.9	1,000,000
Southern Aroostook	52,404	4.1	215,000
St. John Valley	48,920	6.9	338,000
Penobscot County	13,765	4.4	60,000
Kennebec County[3]	7,810	5.5	42,000
Somerset County	7,245	7.1	51,000
Androscoggin Valley	6,603	7.2	47,000
Oxford County	6,041	2.7	16,000
Cumberland County[4]	3,890	4.1	16,000
Waldo County	3,206	5.6	18,000
Piscataquis County	2,687	5.2	14,000
Franklin County	2,434	2.3	5,000
York County	2,223	5.1	11,500
Knox-Lincoln	354	13.3	4,700
Washington County	160	1.9	300
Hancock County	46	8.9	400
Totals	302,742	6.0	1,838,700

1 Figures are only for fields 10 acres or larger except for Cumberland and Kennebec Counties.

2 Average soil loss and average sheet and rill erosion figures vary slightly from District reports because of rounding.

3 Includes 950 acres of fields smaller than 10 acres with soil loss problem.

4 Includes some fields smaller than 10 acres in size.



SOURCE: MAINE HIGHWAY COMMISSION
MINOR CIVIL DIVISIONS MAP, 1967

JUNE 1976

Aroostook County in total - three Conservation Districts - has about 246,000 acres (82 percent) of the State's estimated 303,000 acres of cropland (fields 10 acres or larger). Nearly 1,553,000 tons of soil are estimated to erode annually by sheet and rill erosion. This is the most severe problem in the State. Visual testament to the Aroostook erosion and sedimentation problems is provided by the all-too-common washes in potato fields and turbidity of rivers, brooks, and streams after intense summer rainstorms.

In the Androscoggin Valley S&WCD, 75 percent of the cropland with high rates of erosion is on upland soils. In Oxford and Franklin Counties most cropland is concentrated on nearly level land adjacent to rivers and streams. Short slopes and low slope gradients allow row crops to be grown intensively without erosion being a serious problem. Cropland adjacent to the Sandy River in Franklin County and the Saco River in Oxford County are examples of areas having concentrations of cropland with little sheet and rill erosion. In contrast, in the Norway-Paris area of Oxford County where slopes are long (often exceeding 700 feet in length) and steep, the rate of erosion jumps to 11 tons per acre per year.

Corn for silage and grain is the major row crop grown outside of Aroostook County. In Somerset County, 74 percent of the cropland planted to corn was found eroding at more than 4 tons per acre per year. The remaning cropland, with tolerable rates of erosion, is located largely on Hadley soils along rivers. Most of the corn acreage is on gently sloping or moderately steep uplands, and much is grown without the benefit of conservation practices. Most corn acreage is scattered throughout many watersheds in the central and south-central counties. In contrast, potatoes are grown in highly cultivated watersheds in the eastern portions of Aroostook County and in a few central Penobscot County townships. Such concentration creates a high potential for detrimental effects from sediment and related farm chemicals on water bodies. Sediment in water bodies is a serious problem in Somerset, Kennebec, and Androscoggin Counties where corn is grown continuously in several highly cultivated watersheds.

Serious erosion occurs on rented land where corn or potatoes are often grown continuously with little regard for erosion control. In the Androscoggin Valley S&WCD more than half the cropland with soil loss greater than 5 tons per acre per year is on rented fields.

Although the State's most extensive erosion and sedimentation problems are in Aroostook County, there are other waterways throughout Maine being polluted by sediment originating from cropland.

On a statewide basis, about 41 percent of all cropland currently has land treatment adequate to prevent intolerable soil erosion rates. Erosion on the remaining 59 percent (about 175,000 acres) could be brought to tolerable levels through one or more conservation practices. Generally, the higher the average annual soil loss the more numerous and complex the conservation practices needed. About 39,100 acres are losing more than 10 tons of soil each, per year. Thus, 13 percent of the cropland generates about 762,000 tons of soil moving on the land annually or about 42 percent of the soil loss in the State (see Table 2).

At least 1 inch of soil is eroded every 10 years from fields now losing more than 10 tons per acre per year. Depending on soil conditions, fields with severe erosion problems eventually become useless for growing cultivated crops.

The accompanying maps will assist Districts in locating areas of high soil loss and directing their resources to reduce these problems.

Gully Erosion

Gully erosion is concentrated in the Central Aroostook and St. John Valley Soil and Water Conservation Districts. There are 16.5 miles of active gullies in these two Districts. Only a few active gullies were identified on cropland in Maine's other 14 Districts.

If left unchecked, gullies become a significant source of sediment. To insure that fields can be worked with large equipment, most rills are filled by cultivation before they become deep enough to form gullies. Most gullies observed during the SNAP study developed when uncontrolled runoff from cropland reached undersized ditches along farm and town roads. Some gullies form adjacent to crop fields, often as the result of concentrated runoff from several fields.

The accompanying soil loss maps show the location and extent of gully erosion in Maine.

Factors Influencing Soil Loss

The SNAP appraisal revealed tillage operation on long and steep slopes to be the major factor causing high rates of erosion on 154,000 acres of cropland. Land which is nearly level with only short slopes is less likely to erode, regardless of the method of cultivation or length of rotation (see Table 3).

TABLE 2 - PERCENT AND ACRES OF CROPLAND BY SOIL LOSS CATEGORIES

Soil and Water Conservation Districts	Cropland Acres[1]	Soil Loss Categories - tons per acre per year: 0-3 Percent	0-3 Acres	3 tons[2] TOLERABLE SOIL LOSS LIMIT	4-5 Percent	4-5 Acres	6-7 Percent	6-7 Acres	8-10 Percent	8-10 Acres	11-25 Percent	11-25 Acres	26+ Percent	26+ Acres
Androscoggin Valley	6,603	47.5	3,135		13.3	880	12.0	789	6.8	452	15.6	1,030	4.8	317
Central Aroostook	144,954	31.4	45,447		26.5	38,448	16.4	23,748	9.0	13,019	15.5	22,457	1.3	1,835
Cumberland County	3,890[3]	62.0	2,414		17.9	695	7.4	289	4.0	188	4.8	265	1.0	39
Franklin County	2,434	92.5	2,251		5.0	122	2.1	51	-	-	0.4	10	-	-
Hancock County	46	26.1	12		-	-	-	-	45.7	21	28.3	13	-	-
Kennebec County	7,810[4]	48.2	3,765		24.4	1,907	8.4	657	9.3	724	9.3	724	0.4	33
Knox-Lincoln	354	11.6	41		12.4	44	4.5	16	20.6	73	39.8	141	11.0	39
Oxford County	6,041	94.3	5,699		1.2	74	0.8	46	1.0	63	1.9	116	0.7	43
Penobscot County	13,765	45.1	6,205		28.7	3,955	14.9	2,051	8.2	1,126	3.1	428	-	-
Piscataquis County	2,687	51.6	1,387		27.6	741	13.1	351	5.9	159	1.8	49	-	-
St. John Valley	48,920	37.4	18,313		21.8	10,662	12.3	6,014	12.7	6,234	14.5	7,069	1.3	628
Somerset County	7,245	25.4	1,845		27.8	2,012	19.2	1,393	6.9	501	15.4	1,113	5.2	381
Southern Aroostook	52,404	66.6	34,878		17.3	9,067	8.6	4,530	4.0	2,123	3.3	1,725	0.2	81
Waldo County	3,206	33.3	1,069		37.0	1,186	13.0	416	6.3	203	10.4	332	-	-
Washington County	160	92.5	148		-	-	7.5	12	-	-	-	-	-	-
York County	2,223	48.2	1,073		21.0	467	13.7	305	6.2	137	10.4	231	0.4	10
Total	302,742	42.2	127,682		23.2	70,260	13.4	40,668	8.3	25,023	11.8	35,703	1.1	3,406

[1]Fields 10 acres or larger.

[2]Tolerable soil loss limit is established at 3 tons per acre per year for most cropland soil types in Maine.

[3]Includes some fields smaller than 10 acres in size.

[4]Soil loss on 950 acres of fields less than 10 acres have been prorated to appropriate categories.

TABLE 3 - FACTORS INFLUENCING SOIL LOSS

Soil and Water Conservation Districts	Total[1] cropland acres inventoried	Total cropland acres needing treatment	Percent of total in S&WCD	Factors producing excessive erosion[2]			
				Steep slopes	Long slopes	Poor rotations	Up and down hill planting
Central Aroostook	144,954	99,500	69	36,294	45,718	26,018	20,678
Southern Aroostook	52,404	17,526	33	10,297	7,653	3,775	6,273
St. John Valley	48,902	30,607	63	17,503	17,099	6,443	9,786
Penobscot County	13,765	7,560	54	2,294	2,407	1,733	1,720
Kennebec County[3]	7,810	4,045	52	1,269	1,803	931	1,191
Somerset County	7,245	5,400	74	131	2,173	1,462	4,315
Androscoggin Valley	6,603	3,707	56	2,096	2,551	2,139	1,074
Oxford County	6,041	342	6	186	322	330	181
Cumberland County[4]	3,890	1,475	38	645	520	170	148
Waldo County	3,206	2,137	67	514	474	1,615	1,004
Piscataquis County	2,687	1,300	48	323	394	583	--
Franklin County	2,434	183	3	52	61	60	10
York County	2,223	1,150	52	388	766	357	42
Knox-Lincoln	354	313	88	105	299	146	100
Washington County[5]	160	12	8	--	12	12	--
Hancock County	46	34	74	--	24	34	10
Totals	302,742	175,291	58	72,097	82,276	45,808	46,502

[1]Cropland inventoried was on fields 10 acres in size or larger unless otherwise indicated.

[2]A combination of factors influence soil erosion on most fields.

[3]Includes 950 acres in fields less than 10 acres.

[4]Includes some fields smaller than 10 acres in size.

[5]A large part of Washington County's erosion problem is on blueberry land which was not inventoried as part of this study.

Effects of Sheet, Rill, and Gully Erosion on Agricultural Production

The short-term (1 to 10 years) effects of erosion include loss of nutrients, loss of valuable water, and degradation of soil structure resulting in reduced yields, poor quality crops, and lower profits. Deposits of silt and clay at the base of slopes make the use of heavy machinery difficult during wet periods because of muddy conditions. Large rills require special efforts to prevent gully formation.

Over the long term (ten to several hundred years) soil erosion can destroy the land and the State's and Nation's ability to meet food and fiber needs.

Erosion of topsoil slowly shrinks the resource base, rendering some land useless for growing crops. It appears that nearly all recent land abandonment resulting from erosion has been on severely eroding areas in the potato growing region of Aroostook County. A Northern Maine Regional Planning Commission study in central Aroostook County estimated that at least 2,500 acres of once active cropland have been abandoned in the past 7 to 10 years because of erosion. On shallow soils, severe sheet and rill erosion may eventually expose bedrock and possibly prevent further use of a field for row crops. Sample cropland acres studied in the Central Aroostook S&WCD indicate that the number and extent of rock outcrops have increased appreciably over a 28-year period.

Long-term soil erosion results in loss of cropland and concentration of crop production on remaining acreage, thereby increasing the threat to other cropland.

Agriculture is a major industry in Maine. In some rural towns it is the main business and nearly all jobs are farm-related. Agriculture is dependent upon the soil and, in a real sense, when the soil is left unprotected, so is Maine's future.

Effects of Sediment on Water Quality

Not all sediment delivered to lakes and streams by surface runoff is the result of man's activities. Erosion and the resulting sedimentation have been active over geologic time, but man often substantially accelerates the process to the detriment of his environment. It is this accelerated erosion and the subsequent increase in sediment which concerns the people of Maine.

Sediment reduces water quality. Sediment pollutes when it fills reservoirs, lakes, ponds, and wetlands and often carries along pesticide and fertilizer. Sediment increases flooding by decreasing the capacity of streams and drainageways, alters or destroys aquatic life in surface waters, increases water treatment costs, and destroys the recreational value of water.

Several Maine towns have experienced excessive sediment in municipal water supplies, primarily as a result of erosion from cultivated land. Biologists have reported several small manmade and natural ponds in advanced stages of eutrophication because of nutrient enrichment from cropland.

Effects of Sediment on Fish and Wildlife

Sediment deposits and turbidity can reduce the ability of a pond or stream to produce fish and other aquatic organisms in the food chain. Fish habitat can be destroyed by altered spawning areas and young fish can be killed by silt-laden water. Reduction in the number of aquatic insects limits the primary food of salmon, trout, and bass. Over long periods of time fish become fewer and smaller. Poor fishing discourages fishermen, causing a subtle but important economic impact on an area.

Wetlands can protect streams and ponds from sediment and nutrients by trapping and filtering runoff, but excessive deposits limit the life and many values of wetland areas. Waterfowl, songbirds, and furbearers are among the wildlife affected. Wetlands help to reduce runoff and prevent floods and may be ground water recharge areas.

Sediment Yield to Surface Waters

Not all eroded soil reaches area water bodies. Much is deposited in depressions or is filtered out by natural barriers, such as woodland or grass strips. Road ditches also can collect large volumes of sediment from adjacent cropland. The percentage of the sediment from all sources (including gullies, roadsides, and streambanks) reaching a point in a stream system is referred to as the sediment delivery ratio (see Appendix B). When this ratio is known or can be closely approximated, the sediment yield is estimated by computing gross erosion and multiplying by the sediment delivery ratio.

Since no two watersheds are exactly alike, the amount of sediment reaching surface waters varies. A brief study in Fort Fairfield by SCS and the Northern Maine Regional Planning Commission estimated that over a 10-year period, 15 to 18 percent of soil eroded from two heavily cultivated watersheds reached area water bodies. The two watersheds studied drain 3,350 and 1,800 acres.

Rainfall, drainage area, soils, stream gradient, and proximity of cropland to waterways are among the variables influencing the amount of sediment delivered to rivers and ponds. Size of the drainage area is important in sediment transport because the distance to downstream points is greater in larger watersheds and the opportunities for deposition are more numerous.

The complexity of estimating sediment yield to streams makes it difficult to generalize about delivery ratios. However, the amount of sediment from cropland reaching streams is assumed greater in the heavily cultivated areas of Aroostook County than in other parts of Maine. This assumption is based on the high cropland density and high average erosion rates. Soil texture, relief, and intensive farming also support this assumption. Portions of the Aroostook, Mattawamkeag, and Sebasticook Rivers and the Kenduskeag and Fish Streams draining agricultural land remain turbid for several days after rains.

Local field conditions in other parts of Maine yield high rates of sediment to streams. For example, nearly 100 percent of the sediment eroding from a particular field can be delivered directly to a stream system if the runoff encounters no obstructions and no flattening of the land slope. On the other hand, a wide expanse of forest, wetlands, or other dense vegetative cover below the eroding area may filter out essentially all of the sediment.

Sediment sources other than cropland contribute material to stream systems. In Cumberland County, streambank erosion was identified as the major contributor to sediment loads. Construction activities are another major cause of sediment. Erosion damage from flooding is occasionally severe. (See Appendix F).

Treatment Needed

An estimated 175,000 acres of cropland need conservation treatment to achieve tolerable soil loss. Land and water quality can be degraded by the action of sheet, rill, and gully erosion and subsequent sediment buildup. Severely eroding land eventually becomes difficult, if not impossible, to farm, thus decreasing the land resource base.

Economic factors strongly influence the ability to carry out conservation practices. Farmers have demonstrated a willingness to carry out conservation practices when adequate technical and financial assistance are available. But, some conservation practices--particularly structures--require substantial investments by the farmer; yet these types of needed conservation practices may offer no financial gain. Farmers are unable to recover conservation costs by increasing the value or price of their products. Cost-sharing assistance is available for many conservation efforts, although it is often inadequate for such expensive practices as diversions, outfalls, and waterways. Cost-sharing also fails to offset losses incurred when land is removed from production by conservation practices.

Helping farmers plan and carry out conservation practices requires substantial technical input. Technical assistance needed to control erosion, particularly in Aroostook County, far exceeds available help.

Proper rotations, spring plowing, proper use of manure, proper tillage, and use of cover crops are proven means of protecting soil against excessive erosion. These methods would adequately treat more than half the fields with rates of soil erosion above 3 tons per acre per year.

No-till planting, which employs ground cover as a mulch, effectively reduces erosion on land planted to corn. This practice, along with minimum tillage planting on all cropland, is becoming more common. No-till planting requires an increase in pesticides and the impact of this practice on water quality must be carefully evaluated on a site-by-site basis.

Diversions, grass filter strips, contour plowing, grass and stone waterways, and longer rotations with soil conserving crops are all methods which can be applied when enough land is available, topography is not too irregular, and soils are sufficiently deep. It may be necessary, in the long run, for some badly eroded fields to be used for hayland instead of row crops.

Maine is known for its high quality lakes and streams. The loss of water quality when technology can provide needed remedies is wasteful. In the long run, farmers lose their soil, consumers pay more for milk and potatoes, and both tourists and residents end up with a less attractive environment.

Recommendations of Soil and Water Conservation Districts

To improve water quality and insure the continued productivity of the land:

- Give preferential State and Federal income tax rates to farmers when they are operating under an applied soil and water conservation plan which meets SCS Field Office Technical Guide criteria and is approved by a Soil and Water Conservation District.

- Encourage adjustment in property tax policies to recognize nonproductive land and reduce taxes accordingly. (Land used for conservation practices, such as diversions, waterways, and streambank filter strips, does not produce crops, thus should not be taxed as productive cropland.)

- Encourage crop diversification in areas of intensive row cropping. Convert marginal row cropland to soil-conserving crops, such as hay, grain, and pasture. Develop suitable markets within Maine for these alternative crops.

- Pay farmers who rotate crops according to a conservation plan to offset income lost from reduced acres in cash crops.

- Purchase options from row crop farmers to insure that land too steep for row crops is converted to more suitable uses. Base program on present row cropland use and limit options to land presently in production.

- Increase technical assistance to farmers with erosion problems. Allocate additional technical aid to Districts with the worst erosion problems.

- Increase financial assistance to farmers for carrying out conservation practices. Remove annual cost-share limits. (See Appendix A for list of conservation practices.)

- Provide cost-sharing for maintenance of conservation practices.

- Encourage farm lending agencies to consider on-farm conservation needs in the loan process.

- Provide Soil and Water Conservation Districts with authority to share the cost of resource management systems with farmers. (Resource management systems are combinations of conservation practices required to protect land and water and insure a good level of production.)

- Increase educational and informational efforts to encourage landowner participation in conservation programs.

- Coordinate efforts of all State and Federal agencies to develop comprehensive erosion and sediment control programs.

- Provide financial and technical assistance based on a conservation plan prepared by the farmer and approved by his Soil and Water Conservation District. Limit cost-sharing to farmers willing to enter into long-term agreements. Maintenance of conservation practices must be a condition of any agreement.

In no-till planting the grass sod is killed with a herbicide and corn is planted without plowing. The grass cover controls soil erosion.

Grass waterways safely carry runoff water and act as sediment filters.

Stripcropping improves the soil and reduces runoff and water pollution.

Contour rows hold soil in place while trapping raindrops.

II. ANIMAL MANURE STORAGE AND DISPOSAL APPRAISAL

Poultry manure dumped on frozen cornland during the winter can result in a loss of good fertilizer for the farmer, and polluted water for everyone else.

Lack of fencing allows livestock to deposit manure directly in water bodies.

Kinds and Amounts of Manure

The Study of Non-Point Agricultural Pollution (SNAP) inventoried 166,471 animal units (AU) distributed among 2,802 Maine farms. The following chart shows how animal units are calculated.

Animal Unit Equivalents (AU)

1 -	1,000-pound	bull or cow	equals	one	animal	unit
1 -	1,000-pound	horse	"	"	"	"
2 -	500-pound	heifers	equal	"	"	"
7 -	140-pound	sheep	"	"	"	"
14 -	70-pound	lambs	"	"	"	"
250 -	4-pound	chickens	"	"	"	"
3 -	333-pound	hogs	"	"	"	"

Note: A thousand pounds of animal(s) live weight represent an animal unit. An 1,800-pound bull equals 1.8 AU.

This study identified farms with from 10 to over 200 animal units (Table 4). It is estimated another 15,000 animal units on small part-time farms are not accounted for in this study. The major livestock enterprises in the State are poultry, dairy, and beef. There are, however, scattered small herds of sheep, hogs, horses, and goats.

Estimating 74 pounds of manure per animal unit per day, the 101,936 non-poultry AU produce approximately 3,772 tons of manure containing 20 tons of nitrogen and 4 tons of phosphorus each day. Estimating 53 pounds of manure per poultry AU, the 64,535 poultry AU daily produce about 1,710 tons of manure containing 28 tons of nitrogen and 13 tons of phosphorus (Table 5). During the winter (6 months) it is necessary to store approximately 678,960 tons of livestock manure and 307,800 tons of poultry manure.

Poultry

About 61 percent of the poultry farms and 69 percent of the poultry animal units identified in Maine are in Androscoggin, Kennebec, and Waldo Counties (Table 4). Laying hens, layer replacements, and broilers are the major poultry enterprises in the State. Flocks range from several thousand to several million birds.

TABLE 4 - NUMBER OF FARMS WITH OVER 10 ANIMAL UNITS (AU) AND THE NUMBER OF AU IN MAINE'S 16 SOIL AND WATER CONSERVATION DISTRICTS

Soil and Water Conservation Districts	Number of farms with over 10 AU			Number of AU		
	Poultry	Non-poultry	Total	Poultry	Non-poultry	Total
Androscoggin Valley	31	270	301	13,550	10,645	24,195
Central Aroostook	1	59	60	65	1,930	1,995
Cumberland County	46	181	227	1,850	7,400	9,250
Franklin County	14	123	137	1,403	4,227	5,630
Hancock County	8	31	39	1,063	520	1,583
Kennebec County	134	235	369	11,868	16,510	28,378
Knox-Lincoln	--	157	157	--	5,260	5,260
Oxford County	7	113	120	975	5,974	6,949
Penobscot County	33	159	192	3,984	11,118	15,102
Piscataquis County	2	57	59	120	3,880	4,000
Somerset County	61	337	398	7,150	13,005	20,155
Southern Aroostook	--	92	92	--	3,037	3,037
St. John Valley	1	63	64	12	1,502	1,514
Waldo County	167	203	370	18,882	11,251	30,133
Washington County	4	30	34	318	1,007	1,325
York County	31	152	183	3,295	4,670	7,965
Totals	540	2,262	2,802	64,535	101,936	166,471

Most poultry farms are highly automated, concentrated operations with thousands of birds confined in large multi-floor structures. Many large poultry houses have pit (cellar) storage for 3 to 5 years of production. Broiler houses usually are partially cleaned every 8 weeks and completely cleaned once each year. Most poultry manure is used by dairy farmers, either spread directly on cropland or stockpiled for spreading at corn planting time. Ample crop acreage is available in most Districts for recycling manure. However, a few poultry operations in Waldo and Androscoggin Counties that lack land for spreading pile poultry manure in wooded areas with no intention of land spreading or recycling. In Androscoggin County, manure has been dumped on woods roads.

TABLE 5 - ESTIMATED TONS OF MANURE, NITROGEN, PHOSPHORUS, AND POTASSIUM GENERATED DAILY AND ANNUALLY FROM ANIMAL MANURE

Animals	Animal units	Manure (tons)	Nitrogen (tons)	Phosphorus (tons)	Potassium (tons)
Dairy, beef, sheep, horses, and hogs	101,936	3,772	20	4	10
Poultry	64,535	1,710	28	13	11
Daily total		5,482	48	17	21
Annual total		2,000,930	17,520	6,205	7,665

During the winter, approximately 987,000 tons of manure must be stored from poultry and four-legged farm animals.

Dairy and Beef

Some 101,936 beef and dairy animal units were noted in the SNAP appraisal. Beef enterprises scattered across the State are smaller than dairy farms. Dairy herds are likewise found in most regions, although the greatest concentration is found within a 50-mile radius of Waterville. In recent years the number of livestock farms has declined, but average herd size has increased.

TABLE 5A- DAILY PRODUCTION AND COMPOSITION OF LIVESTOCK MANURE (feces and urine)*
(Upper figure is average; lower figure represents the range given in literature. Dashes indicate data not available or entry not appropriate)

	Dairy Cattle	Beef Cattle	Feeder Swine	Breeder Swine	Poultry	Ducks 1/	Sheep	Horses
			lb/day/1,000 lb live weight					
Manure	85 72-90	62 41-88	69 50-90	50	53 32-67	---	36 30-40	50 40-60
Total solids	9.3 6.8-13.5	8.9 6.0-11.1	7.2 6.0-9.0	4.3	13.9 9.0-17.4	24 2/ 13-31 2/	9.5 8.4-10.7	17.5
Volatile solids	6.9 5.7-7.9	6.9 4.8-8.2	5.7 4.0-7.0	3.2	10.8 8.0-12.9	14.5 2/ 8.7-17.5 2/	8.0 6.0-9.1	---
BOD	1.4 0.8-1.8	1.5 1.0-1.8	2.3 2.0-2.8	1.3	3.4 1.6-5.5	5.1 4.1-7.6	0.8 0.7-0.9	1.4
COD	8.4 4.2-13.3	7.9 6.6-9.0	5.9 4.7-7.1	5.2	12.5 9.5-15.8	---	10.0 7.5-12.0	---
Total nitrogen as N	0.37 0.29-0.51	0.43 0.30-0.58	0.45 0.20-0.70	---	0.86 0.45-1.50	1.42 1.17-1.62	0.40 0.34-0.45	0.30
Total phosphorus as P	0.069 0.026-0.100	0.090 0.023-0.170	0.17 0.09-0.27	---	0.40 0.20-0.75	0.62 0.4-0.9	0.075 0.040-0.120	0.12
Total potassium as K	0.20 0.08-0.35	0.23 0.11-0.38	0.25 0.10-0.60	---	0.35 0.12-0.50	0.9 0.6-1.2	0.32 0.24-0.40	0.25

1/ Based on production figures per 1,000 ducks and assuming an average weight of 4 pounds per duck on swim water.

2/ Suspended solids.

* From Agricultural Waste Management Field Manual, SCS

Most dairy farms confine cows to barns and loafing areas all year. Young stock and dry cows are pastured in the summer months. It is estimated half the dairy farms have some type of storage facility for several months' manure production. Nearly all dairy manure is spread on fields used to produce either corn silage or hay. Adequate land is available for dairy and beef manure disposal in all 16 Conservation Districts. In fact, if all animal manure was properly used in crop production, only a small part of the total fertilizer needs would be met.

Extent of Animal Manure Problems in Maine

This study found the major animal manure problems affecting water quality to be improper storage, poor spreading practices, and direct entry of animals into water bodies. Most of these instances occur to some degree in all Soil and Water Conservation Districts. The most widespread abuse affecting local water quality is improper storage of manure.

Dairy and Beef Manure Storage Problems

Storage problems are due to both inadequate storage facilities in the barnyard and inadequate temporary storage sites in the field. The following are the major manure storage problems identified in the Conservation District assessments of animal manure storage and disposal.

1. Manure piles located in natural drainageways, subject to flow in the spring or after heavy and prolonged rains.

2. Manure stacking adjacent to brooks, streams, or lakes.

3. Manure piles located on steep slopes adjacent to watercourses where runoff containing solids and nutrients can reach the surface waters.

4. Stacking of manure on flood prone areas.

5. Manure piles located in outlet area of barn roof drainage.

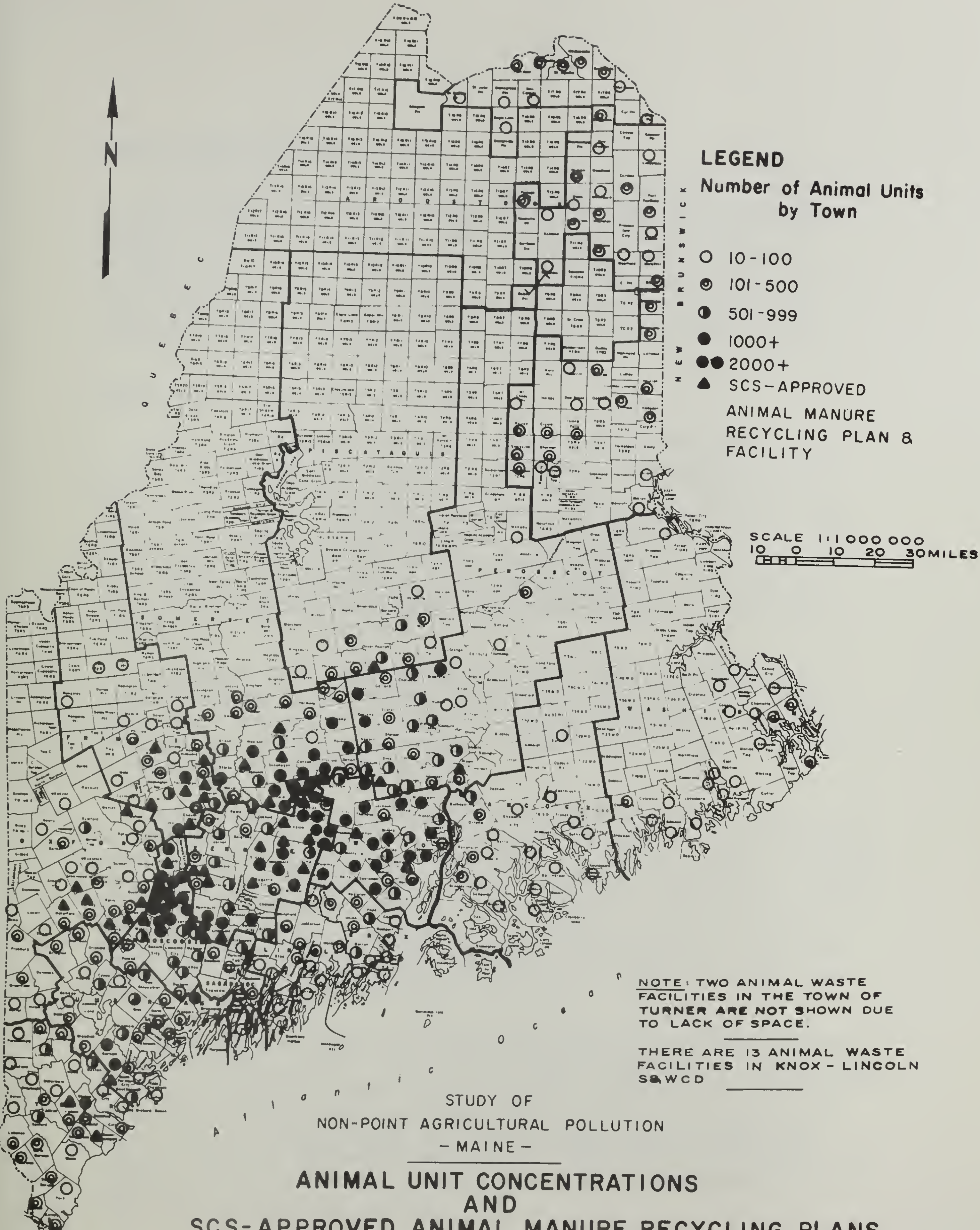
These problems are commonly associated with beef and dairy operations. Similar problems occur on some poultry enterprises where adequate on-farm storage facilities are not available.

Spreading manure on frozen or snow-covered ground and allowing large numbers of animals to water directly from brooks are problems on some farms. Most winter spreading occurs because of inadequate on-farm storage facilities. Proper fencing and stock water ponds would reduce or prevent direct contamination of surface water.

The following map indicates the concentration of animal units and the number of livestock farms with manure recycling plans and storage facilities on a township basis.

TABLE 6 - NUMBER OF FARMS WITH ANIMAL MANURE RECYCLING PLANS AND STORAGE FACILITIES AND NUMBER OF LIVESTOCK FARMS WITHOUT FACILITIES MEETING CRITERIA OF THE SCS FIELD OFFICE TECHNICAL GUIDE IN EACH SOIL AND WATER CONSERVATION DISTRICT

Conservation District	Number of farms with plans and facilities	Number of farms without plans and facilities
Androscoggin Valley	7	294
Central Aroostook	0	60
Cumberland County	1	266
Franklin County	6	131
Hancock County	0	39
Kennebec County	13	356
Knox-Lincoln	13	144
Oxford County	7	113
Penobscot County	2	190
Piscataquis County	1	58
St. John Valley	0	64
Somerset County	4	394
Southern Aroostook	2	90
Waldo County	2	368
Washington County	0	34
York County	2	181
Totals	60	2,782



STUDY OF
NON-POINT AGRICULTURAL POLLUTION
- MAINE -

ANIMAL UNIT CONCENTRATIONS AND SCS-APPROVED ANIMAL MANURE RECYCLING PLANS AND FACILITIES

SOURCE: MAINE HIGHWAY COMMISSION
MINOR CIVIL DIVISIONS MAP, 1967

JUNE 1978

Poultry Manure Storage Problems

One special problem confronting broiler enterprises is storage of manure after clean-outs during the winter and early spring. Storage is often hampered by snow or muddy conditions when no adequate sites are available. It is not uncommon for manure to be piled adjacent to paved roads. Although roadside sites are handy for manure disposal, many are poorly drained, subject to flooding, adjacent to streams and drainageways, allowing runoff to carry contaminants into surface waters.

Animal Manure as a Water Pollutant

Major constituents of animal manure include nitrogen, phosphorus, and potassium compounds. These are present in relatively high concentrations and where animal manure is not incorporated into the soil (i.e., properly stockpiled or spread), the potential for high nutrient concentrations in surface runoff is great. Even with proper land spreading based on soil types and soil incorporation methods, concentrations of manure applied per acre must be carefully controlled to prevent excessive leaching of nutrients into ground water resources.

Pollution by animal manure can create health problems for people, livestock, and aquatic life when large amounts of fresh manure get into water. Bacteria, viruses, protozoans, and fungi are among the potential pathogens. These are primarily of concern in drinking and swimming water.

Most normal sanitary agricultural operations where manure is properly stored or spread on land greatly reduce the potential for water pollution. The easily detectable but harmless fecal coliform bacteria present in all warm blooded animals are used only as indicators of the degree of health risk involved for swimming or drinking water which may be contaminated by animal manure. Harmful organisms can accompany fecal coliforms. The degree of risk and potential for pollution vary depending on the type of animal and amount of fresh manure reaching the water.

Enrichment of lakes and ponds can result in excessive growth of algae causing taste, odor, and aesthetic problems and decreasing the value for water supply and recreation. Fish can be killed in ponds with serious algae problems. Opportunities for fishing can be reduced. Decaying algae and other plants deplete dissolved oxygen supplies, thus suffocating fish. High levels of nitrate in ground water used for water supply can cause methemoglobinemia, a rare blood disorder in infants.

Improper manure handling can cause odor and sanitation problems, increases in fly populations, and aesthetic problems. It also results in waste of a valuable fertilizer resource.

Proper application of manure to the land is conservation in the best sense. Livestock and poultry manures contain different amounts of important nutrients (Table 5A). Each crop requires a particular nutrient mix for maximum production. Table 7 outlines some application requirements to meet crop nutrient needs. Tables 8 and 9 show possible application of manure-supplied nutrients.

TABLE 7 - FERTILIZER NEEDS OF VARIOUS CROPS

Crop	Nitrogen needs per acre per year (pounds)	Phosphorus needs per acre per year (pounds)	Potassium needs per acre per year (pounds)
Corn, all purposes	250	70	120
Sorghums	300	70	120
Hay crops	300	40	120
Vegetables	50	50	100
Alfalfa	--	60	312
Irish potatoes	150	120	250
Small grains	80	25	120

The valuable nutrients in manure should be preserved through proper storage and applied for crop production.

TABLE 8 - ALTERNATIVES FOR APPLICATION OF MANURE-SUPPLIED NITROGEN TO CROPLAND

			Use of Fertilizer					
Animals	AU	Nitrogen produced annually (pounds)	On corn at 250 pounds per acre per year (acres)	On sorghums at 300 pounds per acre per year (acres)	On hay crops at 300 pounds per acre per year (acres)	On vegetables at 50 pounds per acre per year (acres)	On Irish potatoes at 150 pounds per acre per year (acres)	On small grains at 80 pounds per acre per year (acres)
Dairy, Beef, Sheep, Horses, Hogs	101,936	14,882,656	59,531	49,609	49,609	297,653	99,218	186,033
Poultry	64,535	20,257,536	81,030	67,525	67,525	405,150	135,050	253,219
Total	166,471	35,140,192	140,561	117,134	117,134	702,803	234,268	439,252

TABLE 9 - ALTERNATIVES FOR APPLICATION OF MANURE-SUPPLIED PHOSPHORUS TO CROPLAND

			Use of Fertilizer						
Animals	AU	Phosphorus produced annually (pounds)	On corn at 70 pounds per acre per year (acres)	On sorghums at 70 pounds per acre per year (acres)	On hay crops at 40 pounds per acre per year (acres)	On vegetables at 50 pounds per acre per year (acres)	On alfalfa at 60 pounds per acre per year (acres)	On Irish potatoes at 120 pounds per acre per year (acres)	On small grains at 25 pounds per acre per year (acres)
Dairy, Beef, Sheep, Horses, Hogs	101,936	2,976,531	42,522	42,522	74,413	59,531	49,609	24,804	119,061
Poultry	64,535	9,422,110	134,602	134,602	235,553	188,442	157,035	78,518	376,884
Total	166,471	12,398,641	177,124	177,124	309,966	247,973	206,644	103,322	495,945

Nutrients from Manure

Animal manures are applied to agricultural lands to promote plant growth, improve soil structure, and to safely dispose of wastes. Before supplies of synthetic nitrogen fertilizers became readily available, manure was a major source of nitrogen for crop production and animal manure was highly prized. In many parts of the world great competition exists for animal manure. Today, with increased energy costs, there is a renewed interest in animal manure as a fertilizer. Animal manure is usually a good source of many essential plant nutrients. A cropland management program properly using animal manure increases soil organic matter and improves soil structure. Improved soil structure can boost crop production by conserving moisture and valuable fertilizer. Soil with improved structure allows water to infiltrate, thereby reducing runoff, erosion, and loss of nutrients.

Purdue University conducted a study to appraise the nutrient content of cow manure and its value to dairymen. This investigation compared nutrient value of manure packs vs. lagoons vs. open lots. The researchers found that manure pack nutrients from a 1,000-pound cow are worth $35.52 annually if promptly plowed under. Weather-exposed, open lot manure from the same animal is worth $19.88[1]. Manure values were measured against costs of the same nutrients in commercial fertilizer. The following chart, reproduced from the Purdue report, shows the value of manure for the different handling methods.

Nutrient Value of Manure from a 1,000-Pound Animal Per Year

Value of manure pack plowed under	Value of open lot plowed under	Value of lagoon irrigation system
$14.56 N (Nitrogen)	$ 7.96 N	$ 3.68 N
12.00 P (Phosphorus)	7.20 P	3.36 P
8.96 K (Potassium)	4.72 K	6.40 K
$35.52	$19.88	$13.44

---

1 Stoddard, Carlton D. 1977.

It is difficult to estimate the concentrations and amounts of nutrients (nitrogen, phosphorus, and potassium) actually reaching ground and surface water as a result of improper animal manure management. There is a lack of research on this subject. Pollution varies by kind and amount of manure, bedding practices, feeding practices, disposal method, and location of disposal activity with respect to soils, surface water, and rainfall. (See Appendix F.)

Studies conducted in the Cobbossee Watershed District (Kennebec County) in connection with "208" water quality planning showed 10 percent of all animal-related phosphorus components produced in the watershed eventually reached area lakes. Phosphorus runoff from manured fields averaged 1.43 $\pm$ .36 pounds per acre per year. Excessive phosphorus runoff from manure was found to be primarily the result of inadequate manure disposal and/or storage practices. Manure should not be spread on frozen or snow-covered ground because it will contaminate runoff water in the spring. Either a concrete storage pit for solid manure or an earthen lagoon for storage of liquid manure is recommended. Nutrient contamination of State water bodies has occurred from improper winter storage practices.

Most nutrients in properly applied manure are used up by normal decomposition and plant growth. Runoff from rains and snowmelt can transport 10 to 20 percent of the nitrogen and phosphorus in manure which has been spread on frozen or snow-covered fields.

Improper location of stockpiled manure can cause water pollution. Slope and soil characteristics of the site determine whether nutrients will be carried into surface waters or easily leached into ground water. If manure is stockpiled near surface water, nutrient loss and contribution to the water resource will be substantially greater. The "Maine Guidelines for Manure and Manure Sludge Disposal" recommends manure be spread only where slope is less than 25 percent. Rates of spreading are specified according to soil type. No spreading is recommended within 25 feet of wells, springs, ponds, lakes, or marine waters. Location of manure stockpiles also is recommended for only certain soils. Stockpiles should not be left for more than 1 year and must be located more than 300 feet from any surface water.

Nearly all Soil and Water Conservation Districts in the State have livestock farms with storage and disposal problems affecting water quality. In Androscoggin County large quantities of manure are trucked to adjacent counties. Franklin County recycles about 500 tons of animal manure annually from Androscoggin. One poorly located manure pile may create severe local water quality problems on a small stream. Watersheds with a concentration of cattle and inadequate manure storage and disposal practices are most likely to have animal waste problems.

The accompanying maps show the locations of livestock farms with more than 10 animal units and those livestock farms with animal manure recycling plans and storage facilities that meet SCS Field Office Technical Guide criteria (Table 6).

Treatment Needed

All livestock (including poultry) farmers should prepare and follow animal manure recycling plans and most should construct appropriate storage facilities and/or select suitable stacking sites. Plans and facilities should meet SCS technical standards and specifications.

Manure storage facilities' costs vary in accordance with number of animals serviced, length of storage, and site conditions. Costs have ranged up to $40,000 per facility. Construction of storage facilities depends on the financial condition of the farmer and level of governmental participation.

Manure recycling plans and facilities require technical expertise in planning, design, and construction. Soil and Water Conservation Districts will assist farmers in preparing animal manure recycling plans. Generally, farmers prefer roofed storage facilities. Open facilities are subject to Maine's annual rainfall of about 40 inches which causes farmers to haul accumulated water to their fields at high costs of labor, machines, and energy.

Recommendations of Soil and Water Conservation Districts

- The public should share the cost of solving agricultural water pollution problems. The farmer generally incurs high costs in building manure storage facilities that cannot be recovered. The public realizes the benefits in terms of cleaner water.

- Any cost-sharing and technical program to assist farmers solve water pollution problems should be carried out according to a conservation plan approved by a Soil and Water Conservation District.

- Manure storage facilities should meet the criteria for the SCS Field Office Technical Guide.

- Stacking and spreading of poultry and livestock manures should be in accordance with the "Maine Guidelines for Manure and Manure Sludge Disposal on Land."

- All livestock farms should develop manure recycling plans and establish, as needed, manure handling and storage facilities.

- Watering facilities should be provided for cattle to prevent direct manure pollution. Where large numbers of animals are concentrated they should be fenced away from drainageways and bodies of water.

- Manure should be incorporated into the soil as soon as possible after spreading on cropland.

- Install and maintain an effective and complete program of soil erosion control.

- Avoid overgrazing pastures. The number of animals grazing a given field should be tailored to soil type, vegetation, and site conditions.

- Develop livestock loafing areas remote from streams and other major drainage channels.

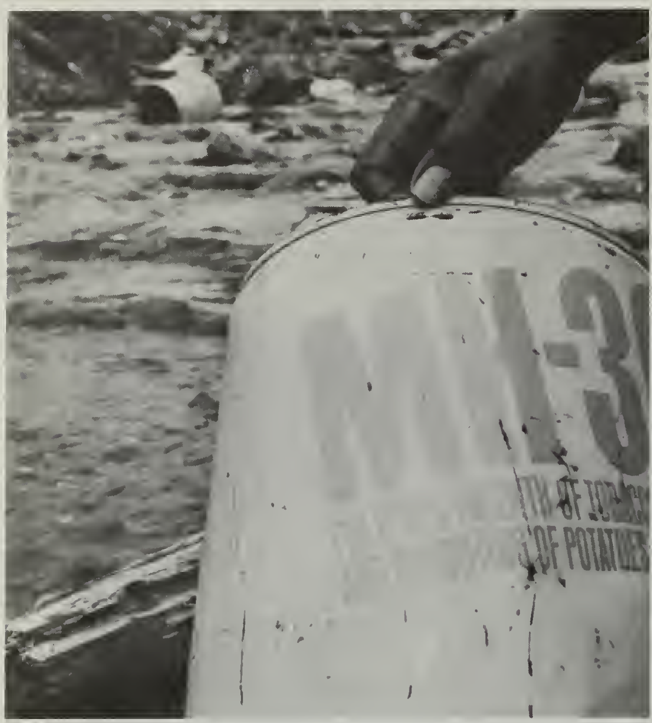
- Keep animals out of areas with critical erosion problems.

- Use water control and disposal systems to modify drainage patterns and reduce uncontrolled runoff of manure.

- Develop multi-agency educational efforts through Soil and Water Conservation Districts under the leadership of the Maine Cooperative Extension Service to motivate farmers to use the best animal manure recycling practices.

III. AGRICULTURAL CHEMICAL USE AND DISPOSAL APPRAISAL

Improper disposal of chemical containers makes water bodies unsafe for humans and wildlife.



Five-gallon chemical containers used in potato production. The "empty cans" (all had residue left in them) were carelessly left beside the stream.

Twenty-two different chemical compounds (for different uses) were counted in a 300-foot stretch of stream.

Methods

To obtain estimates of the quantities of agricultural pesticides and fertilizers used in Maine, several sources were consulted. The amount of chemicals (usually only fertilizer) used on permanent hayland and pastureland is insignificant compared to what is used on cultivated crops. Estimates of acres of each row crop planted in 1977 were made by consulting the Soil Conservation Service (SCS), Agricultural Stabilization and Conservation Service (ASCS), and New England Crop and Livestock Reporting Service. The amounts of chemicals used per acre for each crop were obtained from the 1977 Maine Farm Planning Guide. Local Cooperative Extension agents assisted in estimating the percentages of total cropland acreage sprayed with each chemical.

Documented problems and watersheds with potential problems were identified with the aid of the Pesticides Control Board, the Department of Inland Fisheries and Wildlife, the Soil and Water Conservation Districts, and the SCS. Watersheds with high average soil losses also are considered to provide potential chemical non-point pollution. Information about existing and recommended methods for control was obtained from the Science and Education Administration-Extension and the Pesticides Control Board.

Effects of Nutrients on Water Quality

Individual streams, lakes, and ponds have varying nutrient levels because of the natural characteristics of their watershed. Some bodies of water have naturally low levels of nutrients, while others have higher levels. Eutrophication is a natural process. Generally, the more nutrients and sediment added to a lake or pond, the faster it ages. Phosphorus is the nutrient which has the greatest effect on this aging process in Maine's waters.

Each body of water is unique and can tolerate only a certain level of nutrients. Excesses cause deterioration in water quality. The degree of man's tolerance to deterioration of water quality depends on the use of water (water supply, fishing, or other recreation).

A luxuriant growth of aquatic plants can cause extremes in the dissolved oxygen content of water and stressful conditions for aquatic life. As with all plant life, carbon dioxide is used and oxygen is given off during the daylight hours. As algae and other plants grow and multiply (bloom) in sunlight, oxygen is

added to the water. As temperatures increase, the water holds less oxygen. However, as plants continue to multiply, more oxygen is given off, and the water can become super-saturated, creating a situation unfavorable to fish. At night, the opposite occurs. Plants use oxygen, and as they die and decompose more oxygen is used. When an algae bloom exists, the dissolved oxygen in the water can change from a super-saturated condition to an oxygen-poor condition during the night and on cloudy days. Such oxygen problems generally arise in ponds and not flowing waters. Where problems exist, they generally recur since the nutrients continue to cycle through the plants and sediments. Most nutrients stay in a pond until plants and sediment are physically removed. Chemical treatment of aquatic plants usually makes the situation worse.

Most highly eutrophic ponds and lakes normally cannot support trout or salmon. Swimming becomes less desirable during periods with algae blooms. Nutrient levels in severe cases may also prohibit swimming. Excess algae and aquatic plant growth affect aesthetic values, color, odor, and taste. This pollution has an economic impact by limiting recreation, wildlife, and water supply values.

Many surface waters are enriched by nutrients lost from cropland. Nutrients lost from cropland by erosion and leaching depend on location, soils, and land use. Studies have shown ranges from 0.03 to 3.0 lbs. per acre per year for nitrogen and from 0.01 to 0.72 lbs. per acre per year for phosphorus.[1] Concentrations of major fertilizer nutrients in sediments are: 0.1 percent nitrogen, 0.08 percent phosphorus, and 1.25 percent potassium.[2 and 3]

The toxic effect of excess nitrate nitrogen in drinking water supplies is well known. Above 10 parts per million renders water unfit to drink. High nitrate levels can cause methemoglobinemia, a rare but fatal blood condition in infants. Because nitrates are highly soluble, they can easily enter ground water which may be used for drinking purposes. However, the source of nitrate normally must be concentrated and localized to represent a health hazard.

---

1 Dornbush, J. N., J. R. Andersen, and Leland L. Harms. 1974.

2 U. S. Environmental Protection Agency. 1973.

3 USDA Soil Conservation Service. 1977.

Effects of Pesticides on Water Quality

Pesticides in water can be toxic in aquatic ecosystems and degrade water quality. The movement of pesticides on cropland is generally horizontal rather than downward through the soil profile. Thus, the greatest threat of pesticides is to surface water, although ground water can be affected. One study estimated that .68 pounds of pesticides[1] per acre of land planted to potatoes each year move into the St. John River Basin. An extended period of precipitation is needed to move pesticides deep into soil. It is unusual to find pesticides in the soil below 2 feet. The exception is found in improper container disposal (burial or dumping) which may result in ground water contamination. This is a major problem associated with pesticide use and is discussed later.

Effects of Pesticides on Fish and Wildlife

The most visible results of pesticide contamination are fishkills. These are often due to high concentrations of chemicals entering a water body during a short period of time. Fishkills can occur following a rainfall when runoff enters surface water soon after pesticide application, or when chemicals spill or are accidentally sprayed into the water.

Guthion, the pesticide most commonly used on blueberries, has been responsible for fishkills in Washington County. Recently a serious accident resulted because adequate precautions were not taken during aerial spraying near ponds and streams. More than 10,000 brook trout and 11,000 eggs were killed in 1972 at a Maine fish hatchery in Deblois. This loss cost the hatchery more than $5,000. The highest concentration of Guthion was in spring water, indicating ground water contamination. Recommendations from the hatchery management suggested erosion control and vegetation management to reduce the possibility of sediment and pesticides reaching their water supply.

Most fishkills occur where chemicals have been improperly handled or carelessly applied. Heavy rains following application of pesticides on potatoes in Aroostook County have also resulted in fishkills. Annually, personnel from the Department of Inland Fisheries and Wildlife and the Department of Environmental Protection investigate pesticide-caused fishkills. Since 1973 game

---

1 Working Group on Pesticides. 1970.

wardens have been charged with the enforcement of the Maine pesticide laws. Wardens issued about 50 warnings and prosecuted a dozen court cases in Aroostook County alone between 1973 and 1975. Such enforcement, good public relations, education, and farmer cooperation have apparently reduced fishkills from careless handling of pesticides. Fortunately, fish and other aquatic life repopulate quickly in natural streams if pesticides do not persist or habitat is not destroyed.

Pesticides also may have a more subtle effect on aquatic ecosystems if present at low levels for a long time or if frequent contamination occurs. Behavior and reproduction of fish may be affected by such "chronic toxicity." Biological magnification may occur with some persistent pesticides, such as organochlorines, which degrade at a slow rate and become concentrated in the tissues of organisms high on the food chain.

Persistent pesticides used on forests and farms in past years still haunt us. Traces or undetectable amounts of these chemicals in water have become concentrated in the food chain. An important example is the harmful amounts of chemicals still being found in bald eagles and their eggs. Reproduction of eagles has been seriously limited by persistent pesticides no longer in use.

Pesticide research in this area is limited, but other wildlife and man could be affected.

Although most of today's pesticides are short lived compared to yesterday's chlorinated hydrocarbons, they are extremely toxic when fresh. Therefore, the potential for damage to wildlife may be higher now than in the past.

The long-term effects of modern pesticides on the aquatic environment are difficult to predict, but probably not as severe. The greatest unknown, apparently, is the synergistic (combined) effects of various combinations of pesticides used on a single watershed. Often the effects of two chemicals reacting together cause much greater stress on the environment than the additive effects of each chemical applied independently. Temperature, pH, and hardness of the water cause chemical toxicity levels to vary significantly. For example, some chemicals are more toxic in warm, alkaline waters than in cool, neutral waters. One chemical was found to be twice as toxic at 12°C (53°F) than at 7°C (45°F). Much research is needed before the full effects of chemicals on the aquatic ecosystem are understood.

Transport Mechanisms of Nutrients and Pesticides

Nutrients and pesticides reach ground and surface waters in three major ways: runoff, erosion, and leaching. Pesticides, especially when aerially sprayed, also may reach surface waters directly or by drifting air currents (see Appendix F).

Agricultural chemical concentrations in surface runoff waters depend on the amount of time between application and rainfall, soil moisture conditions, proximity of a watercourse, persistence of the chemicals, the amount used, topography, soil erodibility, soil permeability, and the method of application of the chemical.

A University of Maine at Orono report[1] showed that the ground water supply in the Cherryfield area often approaches maximum pesticide limits for human consumption after blueberry fields have been treated. Nutrients, especially nitrates, are very soluble and may appear in ground water. A study of nitrates in agricultural soils in northern Maine shows that excessive application results in higher levels of nitrate in soil solution. Moreover, a substantial concentration of nitrate in soil solution peaks in early spring before planting. Much of this nitrate is lost to ground water before crops have a chance to use it.[2] It is also thought that very little phosphorus moves into soil water, as it is relatively insoluble. However, knowledge of the chemistry of phosphorus in the soil is inadequate for estimating these amounts.

Research has shown that pesticides from containers buried in a landfill (as recommended by the State for a disposal method) do move in the soil and into ground water. In 1975 pesticide containers were crushed and placed in a pit 6.1 by 15.2 meters, and 1.5 meters deep.[3] Chemicals included Dinoseb, Endosulfan, and Azinphos-Methyl, all commonly used on potatoes. Results to 1977 show that chemicals are moving into the ground water. Dinoseb and Azinphos-Methyl are more mobile than Endosulfan. Although this landfill method of disposal is generally recommended, the results of this experiment indicate need for research into alternative methods of container disposal.

---

[1] Borns, H. W. et al. 1971.

[2] Rourke, Robert V. 1973-1977.

[3] Rourke, Robert V. et al. 1975-1977.

Transport methods and effects of chemicals on aquatic ecosystems are not completely understood.

A satisfactory method must be found for disposal of pesticide containers. The present practices of piling containers in a dump, burying them, or simply leaving them in or near the source of water used in the sprayer all result in contamination of surface and ground water. Incentives to promote compliance must be incorporated in any new disposal method.

Existing Methods for Control

In 1972 the U. S. Congress amended the 1947 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) to regulate all pesticides, providing stronger enforcement and making misuse unlawful. The law requires that all pesticide products be classified for "general" or "restricted" use with the latter to be used only by, or under supervision of, certified applicators.

General use pesticides are those that "will not ordinarily cause unreasonable adverse effects on the user or on the environment when used in accordance with their label instructions." Restricted use pesticides "may cause adverse effects on the environment or the applicator unless applied by competent persons who have shown their ability to use these products safely and effectively." Certification is required for private applicators who use or supervise use of restricted pesticides on property of their own or their employer strictly for producing agricultural commodities. Certification is also required for commercial applicators, including some government employees, persons who apply pesticides for hire, or supervise use of restricted pesticides on any property other than as provided in the definition of private applicator.

The U. S. Environmental Protection Agency (EPA) is responsible for the FIFRA. States are responsible for certification of applicators. State certification plans must be reviewed and approved by EPA which has set up requirements for commercial and private applicator certification.

Synopsis of Maine Pesticide Use Law

The Maine Department of Agriculture administers pesticide control regulations. The Division of Inspection is responsible for enforcement of State pesticide registration and quality control under the Maine Pesticide Control Act of 1975. Every pesticide distributed in the State must be registered with the Department of

Agriculture. Registration is a tool for determining if pesticides meet labeling requirements and do the job intended while protecting health and environment.

The Board of Pesticides Control was created in 1965 to regulate pesticide use in Maine. The Board includes the heads of eight State Departments: Agriculture, Conservation, Inland Fisheries and Wildlife, Marine Resources, Human Services, Transportation, Environmental Protection, and Public Utilities.

One important Board responsibility is to certify and license those who use and sell pesticides. All commercial applicators must be examined and licensed by the Board. Since October 1976 all private applicators, such as farmers, who wish to purchase or use pesticides which the EPA classifies as "restricted" must be certified by the Board, either by examination or by attending an approved training course.

Maine law requires that dealers of restricted-use pesticides also be licensed. Certificates and licenses issued by the Board can be suspended or revoked for various reasons, including using, distributing, or storing pesticides in a faulty, careless, or negligent way; filing false or fraudulent reports; violating the provisions of State or Federal pesticide laws; and using chemicals contrary to label directions.

One part of the law requires dealers and commercial applicators to maintain records and submit reports of their activities. Agents of the Board can enter premises for inspection and sampling. Enforcement can be carried out by personnel of any member agency of the Board. For example, wardens of the Department of Inland Fisheries and Wildlife have been designated to enforce provisions of the pesticide use law dealing with environmental concerns. The Department of Environmental Protection also has jurisdiction if improper pesticide use has contaminated a water body. Sizeable fines can be levied for violation of the law.

Research and Education

The Maine Cooperative Extension Service works with the Pesticides Control Board to carry out a program of education and research in pesticide use. Guidelines on pesticide use for specific crops are published annually, and workshops are held each year to inform farmers of new materials, methods, regulations, and proper pesticide use.

The Integrated Pest Management Program is designed to minimize the number of pesticide applications, while maintaining high levels of production. The concept of a weekly spray program is being discarded in favor of a program based on need as determined by environmental monitoring and insect population evaluation. The three projects in this program include: blight forecasting, which saved cooperators 4.7 sprays in 1977; aphid monitoring and control, which saved cooperators 3 sprays in 1977; and Canada plum eradication, which destroys an aphid alternate host plant. This program, active in some parts of Maine since 1974, has become a total industry effort involving farmers, farm organizations, industry organizations, commercial establishments, and town officials. The program offers promise for improved methods of insect and disease control with minimum use of pesticides.

Trends in Chemical Use

Increased participation of growers in the Integrated Pest Management Program (22 in 1974 to 63 in 1977) indicates a definite interest in more controlled use of agricultural chemicals. Adverse environmental effects are undesirable and chemical costs are significant, so growers are open to suggestions about efficiency. However, maximum production and economics will continue to govern farm management practices. Hopefully, chemical use can be minimized through preventive and management practices.

In the last 10 years there has been a changeover from toxic, long-lasting hydrocarbon pesticides to more toxic but shorter-lived pesticides with fewer known residual effects. This, together with better pesticide management practices and use, has contributed to fewer fishkill reports and pesticide use complaints. This may indicate that total environmental effects are being reduced.

Treatment Needed

Potential pollution from pesticides and nutrients which are water soluble or adhere to sediment can be reduced by soil and water conservation practices.

Reduced water runoff through contour plowing, etc., holds nutrients and some pesticides on the land where they can be used by plants or changed to less harmful chemicals by biological process.

Improved soil structure holds water and provides more organic matter to hold nutrients.

Reduced erosion lessens the amounts of nutrients (primarily phosphorus) and some pesticides destined for surface waters.

Winter cover crops tie up nitrogen through the fall and winter. Spring plowing releases this nitrogen into the soil to aid in crop production, as well as improve soil structure and reduce erosion.

A complete system of conservation practices is essential on all crop fields to significantly reduce pollution. In some fields practices could include a manmade pond or settling basin to intercept farm runoff before being discharged into a public stream or lake.

Conservation planning, technical and economic assistance, legislation, education, and research must be put together to help farmers stay in business, maintain or increase productivity, and contribute to improved water quality.

Recommendations of Soil and Water Conservation Districts

- Research to find practical and safe means of disposing of pesticide containers.

- Encourage recycling of pesticide containers (make them returnable and, where possible, reuseable).

- Discourage purchasing of pesticides in excess of annual needs and long-term storage on farms.

- Encourage development of safe spray water ponds.

- Discourage the mixing of pesticides next to natural bodies of water.

- Encourage hauling water to crop field and mixing pesticides.

- Encourage development of spray water facilities permitting the rinsing of pesticide containers.

- Encourage integrated pest management type programs to minimize use of pesticides.

- Encourage pesticide application and timing in accordance with Cooperative Extension Service recommendations.

- Encourage improved use of fertilizers to reduce chance of ground water and surface water pollution.

- All crop farmers should develop soil and water conservation plans. Erosion control practices are effective in reducing pollution of water by pesticides and fertilizers.

- Better methods of monitoring pesticides and chemical fertilizers need to be developed before any more funds are expended for this purpose. Results of past and present monitoring activities have been inconclusive.

APPENDIX A

CONSERVATION PRACTICES

THE ROLE OF CONSERVATION PRACTICES IN REDUCING NON-POINT AGRICULTURAL POLLUTION[1]

Diversions, waterways, stripcropping, contouring, and animal manure recycling plans, with storage facilities as appropriate, are examples of conservation practices that reduce non-point sources of agricultural pollution. Soil and Water Conservation District cooperators have been using these and many other practices for years in protecting their land and water resources. Conservation practices have proven effective in providing landowners a means to protect the resource base and still allow the land to be used for cultivated crops.

All conservation practices have standards and specifications to assure that they work efficiently over the life of the practice.

Practices, standards, and specifications are discussed in detail in SCS Field Office Technical Guides available in each District Office. This Guide provides technical criteria to help individuals, groups, and units of government in conservation planning and implementation. Practice standards establish the minimum level of acceptable quality for planning, designing, and installing conservation practices. Specifications describe the minimum requirements necessary to install a conservation practice so that it achieves its intended purpose.

Conservation practices improving water quality have been identified in 208 area water quality plans. Planning agencies refer to these conservation practices, described in Field Office Technical Guides, as "Best Management Practices" (BMP's). The term Best Management Practices originated with the rules and regulations developed pursuant to the "Continuing Planning Process" required by Section 208 of the Federal Water Pollution Control Act. This terminology will be used extensively in water quality management plans with reference to the procedures and methods for controlling non-point source pollution.

---

[1] The discussion of Conservation Practices in Reducing Non-Point Agricultural Pollution has been adapted from the Environmental Protection Agency and National Association of Conservation Districts Publication: Conservation Districts and 208 Water Quality Management.

Conservation treatment is site specific and the application of a single practice will seldom achieve all desired effects. The combination of conservation practices selected to meet the needs of a particular land and water problem and to achieve desired effects is referred to as a "Resource Management System" (RMS). Best Management Practices are corollary to this and may include those agronomic, managerial, and structural practices used singly or in combination to reduce non-point source pollution to a level compatible with water quality goals. Technical standards in SCS Field Office Technical Guides serve as a basis for planning and applying conservation and/or Best Management Practices.

Best Management Practices are intended to be an acceptable basis for management of non-point sources to protect water quality and are to be determined by 208 planning agencies and identified in 208 area water quality plans.

The 208 planning agencies in Maine have identified conservation practices benefiting water quality and given them the designation of Best Management Practices. Examples of BMP's adopted in the 208 area water quality plan include:

- Cross-Slope Farming
- Contour Farming
- Diversions
- Grassed Waterways or Outlets
- Crop Residue Management
- Stripcropping
- Minimum Tillage
- Grasses and Legumes in Rotation
- Animal Manure Recycling Plans
- Etc.

Standards and specifications in the SCS Field Office Technical Guide will be followed in planning, designing, and installing conservation practices and/or BMP's.

Soil and Water Conservation District Authorities and Responsibilities

Soil and Water Conservation Districts are legal subdivisions of State government, responsible under State law for conservation work within their boundaries just as townships and counties are responsible for roads and other services and school districts are responsible for education. Sixteen Districts cover virtually all of the privately-owned land in Maine, except for portions of

Maine's unorganized territory. District boundaries are usually drawn along county lines. One county, Aroostook, has three Districts, while two Districts include two counties.

Also working with Districts are many State Departments, such as Conservation, Agriculture, Parks and Recreation, Transportation, Inland Fisheries and Wildlife, and the University of Maine.

Districts have entered into written memorandums of understanding with individual landowners and cooperating State and Federal agencies. These documents spell out goals, working relationships, and how each partner will function. Basically, District assistance in conserving or developing soil and water or related resources is based on the following major elements:

Public Information and Education Assistance: Informing and educating the public about resource management through the media, schools, civic forums, and other organizations.

Inventory and Evaluation Assistance: Providing basic inventory data, such as soil surveys, hydrologic data, vegetative information, and other technical data and interpretations and evaluations of these data.

Planning Assistance: Providing technical assistance to land users in determining alternative land uses and treatment needs and assisting in development of a conservation plan reflecting the specific land use and treatment decisions.

Application Assistance: Providing technical assistance to cooperating land users to help them install planned conservation practices which include engineering and vegetative measures. Assistance may include site investigations, designs and specifications, construction plans, layout of practices, and supervision of installation.

The working arrangements Districts have with Federal and State agencies, institutions, groups, and private landowners provide a mechanism to achieve land and water quality goals. Maine's Soil and Water Conservation Districts share the recent concerns of environmental agencies about reducing water pollutants from agricultural enterprises.

Even though Soil and Water Conservation Districts have the organization to deliver an effective conservation program, there is a real need for additional technical and financial assistance to accelerate resource protection and improvement efforts.

The purposes of Districts are to identify soil and water conservation problems, to develop programs to solve them, and to enlist and coordinate help from all public and private sources in carrying out programs to solve problems.

The Maine Soil and Water Conservation Commission is responsible for helping to organize Districts, coordinating their activities, providing them with financial and other aid, and informing the public about the program.

Each of Maine's 16 Soil and Water Conservation Districts is managed by five local citizens who know area problems. These five members are the governing body and are called the Board of Supervisors. Three are elected by cooperators within the District; two are appointed by the State Soil and Water Conservation Commission.

The responsibilities of the Board of Supervisors are to plan and direct the program, obtain assistance, coordinate the help of government agencies, assign priority to resource development tasks, and serve as a community clearinghouse for information and services.

District Supervisors inventory resource needs and problems and, using public and private assistance, analyze agricultural, economic, and other trends. This inventory forms the basis for a long range plan of action that records the facts about local resources and outlines what must be done to correct problems and develop resources for wider and better use.

To meet these goals, Districts work in two ways: first, they provide technical assistance to individual landowners in planning and installing scientific land use and treatment systems; and, second, they initiate and carry out project type programs as required. Districts also participate actively in group projects and regional resource development programs that benefit citizens in widespread areas. These include watershed projects, economic development projects, river basin development, comprehensive planning, and environmental improvement programs.

Districts, in addition to their own resources, rely on the personnel and facilities of the USDA Soil Conservation Service (SCS) for trained manpower. Several other Federal agencies provide services, including resource-oriented agencies of the United States, such as those in the Departments of Agriculture and the Interior.

Additional technical assistance is needed in areas addressed by this SNAP study as having severe agricultural non-point source pollution problems. A renewed commitment must be made by conservation agencies, groups, and individual landowners to make a concentrated effort to reduce soil erosion and keep farm chemicals and excessive nutrients from entering Maine's ground and surface water.

Along with an increase in personnel to work with District cooperators, financial assistance is needed to encourage farmers to apply needed and oftentimes expensive practices. Although cost-sharing now exists for many erosion control practices, it is often not sufficient to encourage farmers to install such expensive practices as outfalls for erosion control and manure storage pits, both of which can cost many thousands of dollars. Application of some conservation practices offers no direct financial gain to farmers but does require a significant financial investment. The public will be the primary beneficiary in enhancing and protecting Maine's land and water. The public should financially assist ready, willing, and able landowners in solving agricultural pollution problems and insuring the continuing productivity of the soil.

Keeping SNAP Current

The SNAP study provides base line data on soil erosion, quantity of animal manure, and type and quantity of agricultural chemicals being used on a watershed basis. As Districts work with cooperators who have soil erosion or pollution problems, progress will be noted. The SNAP inventory maps will be updated as technicians assist Districts in carrying out their programs. Keeping SNAP current will allow Districts to monitor their progress in achieving their goal of improving Maine's land and water resources. SNAP provides a basis for Districts to redirect programs. State agencies concerned with meeting water quality standards will also be keenly interested in keeping SNAP current as an aid in monitoring the effects on water quality of carrying out practices to solve non-point source pollution problems.

SOIL AND WATER CONSERVATION PRACTICES
(BEST MANAGEMENT PRACTICES)

The following lists of soil and water conservation practices have been taken from the SCS Field Office Technical Guide, Section IV. Practices in the first list directly benefit water quality and are considered Best Management Practices. Practices in the second list have indirect benefits to water quality. Almost all conservation practices provide direct or indirect benefits to water quality. In some parts of the United States, practices such as Irrigation Water Management have direct major water quality benefits. Drainage practices often benefit erosion control efforts as they permit establishment of improved vegetation covers, help stabilize wet soils used for crops and pasture, lower water tables providing an improved filter for animal wastes and chemicals, and permit cross-slope farming on sloping crop fields with drainage problems. Conservation practices are usually used in combinations to treat land use problems. Combinations of conservation practices are referred to as Resource Management Systems.

The following practices provide direct benefits to water quality:

Access Road. A road constructed as part of a conservation plan to provide needed access. This practice permits rearrangement of tillage patterns (cross-slope farming) for erosion control and the improvement of water quality.

Animal Manure Recycling. Animal manure storage and disposal can be properly handled by developing a Waste Management System. A Waste Management System is designed to manage liquid and solid waste, including runoff from concentrated waste areas, with ultimate disposal in a manner which does not degrade air, soil, or water resources.

Animal Waste Storage Facility. A fabricated structure or a specially selected storage site, open to the atmosphere, for temporary bulk storage of animal waste to prevent pollution of the surface and ground water. (Includes planned and designed animal waste stacking areas.)

Clearing and Snagging. Removing snags, drifts, or other obstructions within the channel to help prevent streambank and bottom erosion.

Contour Farming. Farming sloping cultivated land in such a way that plowing, preparing land, planting, and cultivating are done on the contour. This includes following established grades of terraces, diversions or contour strips, contouring orchards, vineyards, or small fruits. This practice reduces soil erosion and the sedimentation of streams and lakes.

Contouring Orchard and Other Fruit Areas. Planting orchard, vineyard, or small fruits so that all cultural operations can be done on the contour. This helps improve infiltration, reduces runoff, and thus reduces amount of pesticides reaching streams and lakes.

Cover and Green Manure Crop. A crop of close-growing grasses, legumes, or small grain planted primarily for seasonal protection and for soil improvement. It usually occupies the land for a period of 1 year or less.

Critical Area Planting. Planting vegetation such as trees, shrubs, vines, grasses, or legumes to stabilize critical areas (does not include tree planting mainly for wood products) to control soil erosion and improve water quality.

Crop Residue Management. Plant residues left in cultivated fields to prevent erosion (includes crop residue use and stubble mulching) and improve water quality.

Cross-Slope Farming. Conducting farming operations on sloping cultivated lands in such a way that tillage, land preparation, planting, and cultivation are done crosswise to the predominant slope, but not on the contour to control soil erosion and improve water quality.

Dam, Diversion. A structure built to divert part or all of the water from a waterway or stream into a different watercourse, an irrigation canal or ditch, or a water-spreading system to control gully erosion, to provide for a stable outlet for runoff water, and to improve water quality.

Debris Basin. A barrier or dam constructed across a waterway or at other suitable locations to form a silt or sediment basin to protect water quality.

Dike. An embankment constructed of earth or other suitable materials. A dike may serve to: (1) protect land against overflow from streams, lakes, and tidal influences, (2) protect flat land areas from diffused surface waters, (3) prevent overflow from washing animal manure into bodies of water, and (4) provide or improve wetland habitat for wildlife.

Disposal Lagoon. An impoundment made by constructing a excavated pit, dam, embankment, dike, levee, or combination of these for disposal of animal waste to protect and improve water quality.

Diversion. A channel with a supporting ridge on the lower side constructed across the slope. The purpose of this practice is to divert water from areas where it is in excess to sites where it can be used or disposed of safely, thereby protecting soil and water quality.

Land Smoothing. Removing irregularities on the land surface by use of special equipment. This ordinarily does not require a complete grid survey of the entire field. This includes operations ordinarily classed as rough grading. It does not include the "floating" done as a final step in a Land Leveling or Land Grading job. This practice helps insure good vegetation cover providing erosion control.

Fencing. Enclosing or dividing an area of land with a suitable permanent structure that acts as a barrier to livestock to prevent or reduce pollution of a stream or body of water.

Field Border. Establishing a border or strip of perennial vegetation at the edge of a field by planting or converting from trees to herbaceous vegetation or shrubs. These are effective in filtering runoff water and in improving water quality.

Floodwater Diversion. A graded channel with a supporting embankment or dike on the lower side constructed on lowland subject to flood damage (does not include Floodway or Diversion). This practice helps prevent soil erosion and the washing of animal wastes into water.

Floodwater Retarding Structure. A single-purpose structure providing for temporary storage of floodwater and for its controlled release to prevent floods and help control soil erosion and the washing of pesticides and fertilizers into water.

Floodway. A channel excavated across a flood plain or along the overflow area of a stream or river (floodway may be bounded by a dike or a levee) to prevent floods and help control soil erosion and the washing of pesticides and fertilizers into water.

Grade Stabilization Structure. A structure to stabilize the grade or to control head cutting in natural or artificial channels. Grade stabilization structures are installed to stabilize the grade and control erosion in natural or artificial channels, prevent the formation or advance of gullies, and reduce environmental and pollution hazards.

Grassed Waterway or Outlet. A natural or constructed waterway or outlet shaped or graded and established in vegetation suitable to safely dispose of runoff from a field, diversion, terrace, or other structure to prevent excessive soil loss, formation of gullies, and water pollution.

Grasses and Legumes in Rotation. Establishing grasses and legumes, or a mixture of them, and maintaining the stand for a definite number of years as part of a conservation cropping system to reduce soil erosion and improve water quality.

Heavy Use Area Protection. Protecting heavily used areas by establishing vegetative cover, by surfacing with suitable materials, or by installing needed structures to reduce soil erosion and improve water quality.

Hedgerow Planting. Establishing a living fence or hedgerow of shrubs or trees within, across, or around fields. This practice is effective in filtering runoff water and improving water quality.

Lined Waterway or Outlet. A waterway or outlet with an erosion-resistant lining of stone. The lined section extends up the side slopes to designed depth. The earth above the permanent lining may be vegetated or otherwise protected to prevent gully erosion and to improve water quality.

Minimum Tillage. Limiting the number of cultural operations to those that are properly timed and essential to produce a crop, yet prevent soil damage.

Mulching. Applying plant residues or other suitable materials not produced on the site to the soil surface to conserve moisture, prevent surface compaction or crusting, reduce runoff and erosion, control weeds, help establish plant cover, and improve water quality.

Pasture and Hayland Management. Proper treatment and use of pastureland and hayland to insure a good vegetative cover, reduce soil erosion, and filter pollutants.

Pipelines. Pipelines are installed to convey water for livestock or recreational use to help insure livestock do not enter and directly pollute bodies of water.

Pond Sealing or Lining. Installing fixed lining or impervious material or treating the soil in a pond mechanically or chemically to prevent excess water loss. This practice seals manure storage lagoons to prevent water pollution.

Proper Timing and Application of Pesticides and Fertilizers. Using pesticides and fertilizers to meet crop production needs, but preventing water pollution by limiting the amounts used and timing applications to plant requirements.

Spring Development. Improving springs and seeps by excavating, cleaning, capping, or providing collection and storage facilities to insure animals do not directly pollute bodies of water and do not destroy vegetative cover.

Streambank Protection. Stabilizing and protecting banks of streams or excavated channels against scour and erosion by vegetative or structural means to prevent water pollution.

Stream Channel Stabilization. Stabilizing the channel of a stream with suitable structures to reduce soil erosion and improve water quality.

Stripcropping Contour. Growing crops in a systematic arrangement of strips or bands on the contour to reduce runoff, reduce soil erosion, and improve water quality. The crops are arranged so that a strip of grass or close-growing crop is alternated with a strip of clean-filled crop or fallow, or a strip of grass is alternated with a close-growing crop.

Stripcropping Field. Growing crops in a systematic arrangement of strips or bands across the general slope (not on the contour) to reduce soil erosion, reduce runoff, and improve water quality. The crops are arranged so that a strip of grass or close-growing crop is alternated with a clean-tilled crop or fallow.

Structure for Water Control. A structure in an irrigation or drainage system for water management that conveys water, controls the direction or rate of flow, or maintains a desired water surface elevation in a natural or artificial channel. Also includes any structure for managing water levels for wildlife or other purposes. (Does not include Floodwater Retarding Structure; Diversion Dam; or Grade Stabilization Structure.) This practice helps reduce soil erosion and gully formation and improves water quality.

Subsurface Drain. A conduit, such as tile, pipe, or tubing, installed beneath the ground surface which collects and/or conveys drainage water to permit cross-slope or contour farming, thus improving erosion control and water quality.

Surface Drain. A graded ditch for collecting water within a field to improve soil and water quality.

Technical Assistance to Soil and Water Conservation Districts to help farmers plan and install soil and water conservation practices to improve and protect water quality.

Terrace. An earth embankment, channel, or a combination ridge and channel constructed across the slope to prevent soil erosion, reduce runoff, and improve water quality.

Tile Drains. Installing drains, such as tile, pipe, or other covered drains, of suitable sizes beneath the surface on a planned grade. This practice has major water quality benefits when used to permit cross-slope farming in growing row crops, such as potatoes, to reduce runoff, control soil erosion, and limit sediment, pesticides, and fertilizers from entering surface and ground water.

Trough or Tank. A trough or tank, equipped with needed devices for water control and waste water disposal, installed to provide drinking water for livestock. This practice helps to insure that livestock do not directly pollute bodies of water.

Waste Storage Pond. An impoundment made by excavation or earthfill for temporary storage of animal or other agricultural waste. Waste storage ponds serve as a component of a waste

management system and are used to store liquid and solid waste, waste water, and polluted runoff to reduce pollution and protect the environment.

Waste Utilization. Using agricultural or other wastes on land in an environmentally acceptable manner while maintaining or improving soil and plant resources. To safely use wastes to provide fertility for crop, forage, or fiber production; improve or maintain soil structure; prevent erosion; and safeguard water resources.

Well. A well constructed or improved to provide water for irrigation, livestock, or recreation. This practice helps insure livestock do not directly pollute bodies of water.

Wetland Wildlife Habitat Management. A wetland constructed or improved to provide wildlife habitat. This practice helps to trap sediment and nutrients and protect water quality.

The following three practices are used primarily when erosion is so severe as to render continued tillage impossible and/or uneconomic under given soil loss objectives.

Pasture and Hayland Planting. Establishing long-term stands of adapted species of perennial, biennial, or reseeding forage plants on land converted from other uses. (Inclues pasture and hayland renovation. Does not include grassed waterway or outlet on cropland.)

Tree Planting. Planting tree seedlings or cuttings. To establish a stand of trees for the conservation of soil and moisture and watershed protection.

Upland Wildlife Habitat Management. The conversion of cropland to vegetation creating a habitat for upland wildlife to control soil erosion, reduce runoff, and improve water quality.

Other soil and water conservation practices with indirect benefits are as follows:

Controlled Burning. Using fire to improve forage production, wildlife habitat, or the production of wood products under conditions where the area to be burned is predetermined and the intensity of the fire controlled.

Farmstead and Feedlot Windbreak. A narrow belt of trees or shrubs established adjacent to a farmstead or feedlot.

Field Windbreaks. Suitable trees and/or shrubs and/or grasses planted in a strip or belt within or around a field.

Fish Pond Management. Developing or improving a fish pond by fertilizing, liming, using fish toxicants, feeding, controlling diseases and parasites, or by other means.

Fish Stream Improvement. Improving streams by various practices which provide cover, spawning areas, improve water quality, or otherwise enhance fish habitat.

Irrigation Pipeline. A pipe or other closed conduit installed in an irrigation system.

Irrigation Pit or Reservoir. Small storage reservoir constructed to regulate flow to the irrigator. Includes open pits excavated below the ground surface to intercept and store either surface water or ground water for irrigation.

Irrigation Storage Reservoir. An irrigation water storage reservoir made by constructing a dam.

Irrigation System. A planned irrigation system where all necessary facilities have been installed for the efficient application of water for irrigation by means of perforated pipes or nozzles operated under pressure. Drip irrigation systems are installed to apply irrigation water efficiently directly to the plant root zone to maintain soil moisture within the range for good plant growth without excessive water loss, erosion, reduction in water quality, or salt accumulation. A planned irrigation system where all necessary facilities have been installed for the efficient application of water directly to the root zone of plants by means of applicators (orifices, emitters, porous tubing, perforated pipe, etc.) operated under low pressure. The applicators may be placed on or below the surface of the ground. Includes a tailwater recovery facility to collect, store, and transport irrigation tailwater for re-use in the farm irrigation distribution system. Tailwater recovery systems are installed to conserve farm irrigation water supplies and water quality by collecting the water that runs off the field surface and making this water available for re-use on the farm.

Irrigation Water Conveyance. A pipeline and appurtenances installed in an irrigation system. The conservation objectives of this pipeline practice are to prevent erosion, loss of water quality, or damage to the land; to make possible the proper management of irrigation water; and to reduce water conveyance losses.

Irrigation Water Management. The use and management of irrigation water, where the quantity of water used for each irrigation is determined by the moisture-holding capacity of the soil and the need of the crop, where the water is applied at a rate and in such a manner that crops can use it efficiently and significant erosion does not occur. (Includes the timing of irrigations to meet crop needs, the control and adjustment of stream sizes to prevent erosion, and control of lengths of "set" to reduce water losses.)

Obstruction Removal. Removing rock, stone fences, hedges, or fence rows and filling gullies or abandoned roads. (Does not include Brush and Weed Control or Land Clearing.)

Pond. A water impoundment made by constructing a dam or embankment or by excavating a pit or "dugout." (Such ponds do not include Spring Development or Irrigation Reservoirs.)

Pumping Plant for Water Control. A pumping facility installed for removing excess surface or ground water from lowland or for pumping from wells, ponds, streams, and other sources.

Sprinkler Irrigation System. A planned irrigation system with all necessary facilities installed for the efficient application of water for irrigation by means of perforated pipes or nozzles operated under pressure.

APPENDIX B

SEDIMENT DELIVERY RATIO

Sediment Delivery Ratio

To determine an average sediment delivery ratio, the magnitude of the sediment yield at a given point in a watershed and the total amount of erosion must be known. The formula is DR = Y/E where Y = the sediment yield at the downstream location and E = the total (gross) erosion, which includes gully, channel, and sheet-rill erosion above that location.

The sediment delivery ratio (DR) is usually expressed as a percentage.

Rough estimates of sediment delivery can be made from the following table.*

Drainage Area (square miles)	Sediment Delivery Ratio (DR)
0.5	.33
1	.30
5	.22
10	.18
50	.12
100	.10
200	.08

---

* From Control of Water Pollution from Cropland, Volume I, Agricultural Research Service (presently the Science and Education Administration - Federal Research), 1975. Report Number ARS-H-5-1.

APPENDIX C

SOIL AND WATER CONSERVATION DISTRICT OFFICES

The following is a list of Soil and Water Conservation District offices:

Androscoggin Valley Soil and Water Conservation District
(Androscoggin and Sagadahoc Counties)
1 Great Falls Plaza
Auburn, ME 04210

Central Aroostook Soil and Water Conservation District
Agricultural Center Building
P. O. Box 1269
Presque Isle, ME 04769

Cumberland County Soil and Water Conservation District
587 Spring Street
Westbrook, ME 04092

Franklin County Soil and Water Conservation District
11 Broadway
Farmington, ME 04938

Hancock County Soil and Water Conservation District
Federal Building
41 Main Street
Ellsworth, ME 04605

Kennebec County Soil and Water Conservation District
Federal Building and Post Office
40 Western Avenue
Augusta, ME 04330

Knox-Lincoln Soil and Water Conservation District
(Knox and Lincoln Counties)
Federal Building
21 Limerock Street
P. O. Box 904
Rockland, ME 04841

Oxford County Soil and Water Conservation District
1 Main Street
South Paris, ME 04281

Penobscot County Soil and Water Conservation District
89 Hillside Avenue
Bangor, ME 04401

Piscataquis County Soil and Water Conservation District
58 Union Square
Dover-Foxcroft, ME 04426

Somerset County Soil and Water Conservation District
7 High Street
Skowhegan, ME 04976

Southern Aroostook Soil and Water Conservation District
Federal Building and Post Office
Court Street
P. O. Box 158
Houlton, ME 04730

St. John Valley Soil and Water Conservation District
1 Boulduc Avenue
Fort Kent, ME 04743

Waldo County Soil and Water Conservation District
37 Church Street
P. O. Box 364
Belfast, ME 04915

Washington County Soil and Water Conservation District
Federal Building and Post Office
49 Court Street
P. O. Box 121
Machias, ME 04654

York County Soil and Water Conservation District
Post Office Building
30 School Street
Sanford, ME 04073

APPENDIX D

METHODOLOGY FOR THE CROPLAND SOIL EROSION APPRAISAL

Methodology for the Cropland Soil Erosion Appraisal

Erosion surveyors estimated soil loss on about 200,000 acres of cropland in Maine during 1977. Soil erosion was determined by visiting each cropland field over 10 acres in size. Cropland was defined as land planted to a row crop at least once in 5 years. Locations of cropland and all erosion data were recorded on aerial photographs.

Five factors were evaluated before sheet and rill erosion were computed: 1) soil type, 2) length of slope, 3) steepness of slope, 4) presence of conservation practices, and 5) the current cropping and management practices (crop rotations and cultural methods). Values for these factors, as well as a factor for rainfall erosion, were entered into the Universal Soil Loss Equation (USLE), the use of which is described in Appendix G. The computed soil loss, expressed as the average number of tons of soil eroded per acre per year over the crop rotation, was then placed in one of six categories and noted on aerial photographs. The six categories were: 0 to 3, 4 to 5, 6 to 7, 8 to 10, 11 to 25, and 26 or more tons per acre per year.

Also recorded on the photographs were the major factors influencing soil erosion on each field, including steep slopes, long slopes, poor rotations, and up and down hill farming.

The soil erosion surveyors checked each field for gully erosion. Gullies were recorded on the same aerial photographs used for recording rates of sheet and rill soil erosion. Washes which could be filled with ordinary farm tillage equipment were not identified as gullies.

The soil erosion appraisal considered average slope conditions in a field and an estimate of crop management. No attempt was made to interview farmers to determine exact crop rotations and cultural methods. Areas of contrasting soil loss of less than 10 acres within a field were not delineated because of map scale and detail desired in this appraisal. However, these areas were averaged with typical field conditions.

An additional 103,000 acres of cropland were surveyed in 1975 in a nine-township area in Aroostook County. The survey was conducted in a similar manner and the results have been integrated into this report.

APPENDIX E

METHODOLOGY FOR THE ANIMAL MANURE STORAGE AND DISPOSAL APPRAISAL

Methodology for the Animal Manure Storage and Disposal Appraisal

The number and location of animal units were obtained by field observation during the summer of 1977, from the working knowledge of local Soil Conservation Service technicians, and from recent Agricultural Stabilization and Conservation Service (ASCS) cost-sharing application data. The following chart shows how animal units are calculated.

Animal Unit Equivalents (AU)

1 -	1,000-pound	bull or cow	equals	one	animal	unit
1 -	1,000-pound	horse	"	"	"	"
2 -	500-pound	heifers	equal	"	"	"
7 -	140-pound	sheep	"	"	"	"
14 -	70-pound	lambs	"	"	"	"
250 -	4-pound	chickens	"	"	"	"
3 -	330-pound	hogs	"	"	"	"

Note: A thousand pounds of animal(s) live weight represent an animal unit. An 1,800-pound bull equals 1.8 AU.

Past, existing, and potential manure disposal problem areas were noted by technicians on maps during field observations. The location and number of animal units (where more than 10 were counted) were marked on aerial photographs. These data were transferred to base maps provided to the Soil and Water Conservation Districts by the State Planning Office. Soil type, location, amount, and known treatment of animal manure provided an indication of potential water pollution problems. Also noted on the maps next to the animal units category for poultry farms are the approximate acres of land available for spreading poultry manure. Livestock farms with animal manure recycling systems meeting SCS Field Office Technical Guide criteria are identified on the maps.

APPENDIX F

MISCELLANEOUS TABLES

Provided by the USDA Soil Conservation Service
Northeast Technical Service Center
Broomall, Pensylvania

POLLUTANT AVAILABILITY, ADSORPTION/SOLUBILITY CHARACTERISTICS, AND LIKELY PATHWAYS FROM CROPLAND

Pollutant	Availability	Solubility/adsorption	Likely pathways
Sediment:			-soil erosion
Nitrogen: particulate organic	-soil mineralization -manure disposal	-in suspension or adsorbed to soil	-carried in overland flow and soil erosion (similar to soil erosion process)
ammonium	-soil mineralization -manure disposal -fertilizer applications	-strongly adsorbed to soil	-soil erosion and snowmelt
nitrate	-soil mineralization -manure disposal -fertilizer applications -rainfall	-in solution	-subsurface flow
Phosphorus: dissolved inorganic	-soil -manure disposal -fertilizer applications	-in solution and adsorbed to soil	-overland flow and soil erosion
particulate inorganic and organic	-soil	-strongly adsorbed	-soil erosion
Manure: organic matter	-manure disposal	-in suspension	-carried in overland flow (similar to soil erosion process)
Pesticides:	-pesticide application	-most are moderately adsorbed some are strongly adsorbed	-overland flow and soil erosion

NITROGEN MINERALIZATION

Type of Waste	Percent of total nitrogen available 1st year[1]	Percent of remaining nitrogen available 2nd year[1]	Percent of remaining nitrogen available 3d year[1]
1. Fresh poultry manure	90	10	5
2. Fresh swine, cattle, or sheep manure	75	15	10
3. Fresh horse manure	60	10	5
4. Layer manure from pit storage or broiler litter	80	10	5
5. Swine or cattle manure held in covered watertight structure	65	15	10
6. Swine or cattle manure held in an open storage structure or storage pond (not appreciably diluted)	60	15	5
7. Cattle manure with bedding stored under roof	60	15	5
8. Cattle manure stored without roof with only the solids applied	50	10	5
9. Manure stored on open lot, cool humid climate (approximately 2.5 percent nitrogen dry basis)	50	10	5
10. Manure stored on open lot, hot arid climate (approximately 1.5 percent nitrogen dry basis)	45	10	5
11. Effluent from an aerobic or anaerobic lagoon, an oxidation ditch, or a waste storage pond appreciably diluted	40	10	5

1 As an example, if there are 100 pounds of total nitrogen in fresh poultry manure when first applied, 90 pounds will be available the first year, 1 pound available the second year, and 0.45 pounds the third year, i.e.: 1st year - 100 lbs x 0.9 = 90 lbs, 2nd year = 100-90 x 0.1 = 1 lb, and 3rd year = 100-90-1 x 0.05 = 0.45 lb.

NITROGEN LOSS ASSOCIATED WITH VARIOUS MANAGEMENT SYSTEMS FOR MANURE

Number	Management system	Lost	Remaining
		Percent	Percent
1.	Manure liquids and solids held in a covered, essentially watertight structure with contents spread and incorporated before drying.	20-30	70-80
2.	Manure liquids and solids held in an uncovered, essentially watertight structure with contents spread and incorporated before drying.	30-40	60-70
3.	Manure liquids and solids (diluted less than 50 percent) held in a waste storage pond with contents agitated, spread, and incorporated before drying.	30-40	60-70
4.	Manure with bedding held in roofed storage, contents spread, and incorporated before drying.	30-40	60-70
5.	Layer manure, stored in roofed shallow pit, cleaned every 3 to 6 months, and incorporated before drying.	30-40	60-70
6.	Broiler manure on sawdust or shavings, warm humid climate, cleaned every 4 months, and incorporated.	45-55	45-55
7.	Manure without bedding held in unroofed storage, leachate lost with solids spread and incorporated before drying.	45-55	45-55
8.	Layer manure, cool humid climate, stored in roofed, fan ventilated pits, cleaned yearly and incorporated.	50-60	40-50
9.	Manure stored on open feedlot surface in cool humid regions with only the solids spread and incorporated before drying.	50-60	40-50
10.	Manure treated by aerobic lagoon, with surface application by spraying or liquid spreading.	55-65	35-45
11.	Manure stored on open feedlot surface, hot arid region with solids spread annually and incorporated.	60-70	30-40
12.	Manure treated by an anaerobic lagoon or stored in a waste storage pond (if diluted more than 50 percent) with surface application by spraying or liquid spreading.	70-80	20-30
13.	Manure treated by aerobic lagoon or oxidation ditch followed by anaerobic storage of effluent with surface application by spraying or liquid spreading.	80-90	10-20

MILKING COW MANURE CONTENT AND MANAGEMENT SYSTEMS

MANAGEMENT SYSTEM	Estimated nitrogen loss (percent)	Percent final moisture	Shrink ratio	Incorporated nitrogen pounds per ton	Mineralization coefficient [1,2]	Nutrients available first year pounds per ton N	P_2O_5	K_2O
1. Fresh manure, collected and applied daily, incorporated before drying.	10	89	1:1	9	.75	7	3	6
2. Manure collected daily, 30 percent processing water added, stored in covered tank, applied semi-annually, incorporated before drying.	25	92	0.8:1	6	.65	4	2	5
3. Manure placed daily in open storage pond, cool, humid climate, 30 percent processing water added, liquids retained, spread annually in fall, incorporated before drying. Evap. = precip.	35	92	0.8:1	5	.60	3	2	5
4. Bedded manure, unroofed stacking facility (bedding is 10 percent by weight) spread in spring before drying. Cool, humid climate. Evap. = precip.	40	82	0.9:1	5	.55	3	2	4
5. Manure, no bedding, stored outside, leachate lost, spread in spring before drying. Cool humid climate.	50	87	1.2:1	6	.50	3	2.5	4
6. Open lot storage - see beef cattle.								

[1] Phosphorus, in general, is combined in the same organic compounds as is the organic nitrogen. Mineralization of P will be about the same as mineralization of N.

[2] Potassium is found in the liquid portion of the waste and all of it is available the first year, normally.

FEEDER SWINE MANURE CONTENT AND MANAGEMENT SYSTEMS

MANAGEMENT SYSTEM	Estimated nitrogen loss (percent)	Percent final moisture	Shrink ratio	Incorporated nitrogen pounds per ton	Mineralization coefficient [1,2]	Nutrients available first year pounds per ton		
						N	P_2O_5	K_2O
1. Fresh manure, collected and applied daily, no dilution or drying, incorporated before drying.	10	90	1:1	12	.75	9	8	9
2. Covered storage tank, applied and incorporated before drying, diluted with 50 percent additional water.	25	93	0.7:1	6	.65	4	5	6
3. Ventilated storage pit beneath slotted floors, diluted 1:1, emptied every 3 months, incorporated before drying.	35	95	0.5:1	4.2	.60	2.5	3	5
4. Open lot storage, warm humid climate, removed in spring, incorporated before drying.	55	80	2:1	12	.50	6	11	13
5. Open lot storage, hot arid climate, cleaned yearly and incorporated.	70	40	6:1	23	.40	9	26	54

[1] Phosphorus, in general, is combined in the same organic compounds as is the organic nitrogen. Mineralization of P will be about the same as mineralization of N.

[2] Potassium is found in the liquid portion of the waste and all of it is available the first year, normally.

FEEDER BEEF MANURE CONTENT AND MANAGEMENT SYSTEM

MANAGEMENT SYSTEM	Estimated nitrogen loss (percent)	Percent final moisture	Shrink ratio	Incorporated nitrogen pounds per ton	Mineralization coefficient [1,2]	Nutrients available first year pounds per ton N	P_2O_5	K_2O
1. Fresh manure, collected, applied and incorporated daily (before drying).	10	86	1:1	12	.75	9	5	9
2. Manure collected daily, stored in covered tank. No dilution or drying, applied semi-annually. Incorporated before drying.	25	86	1:1	10	.65	7	5	9
3. Bedded, manure pack under roof, cleaned in spring, incorporated before drying (bedding = 75 percent by weight).	35	80	0.9:1	8	.60	5	4	8
4. Open lot storage, cold, humid climate, cleaned in spring, incorporated before drying.	55	70	2:1	14	.50	7	7	14
5. Open lot storage, warm, semi-arid climate, cleaned semi-annually and incorporated.	65	30	5:1	25	.45	11	16	36
6. Open lot storage, hot arid climate, cleaned bi-annually and incorporated.	80	20	6:1	20	.30	6	13	38

[1] Phosphorus, in general, is combined in the same organic compounds as is the organic nitrogen. Mineralization of P will be about the same as mineralization of N.

[2] Potassium is found in the liquid portion of the waste and all of it is available the first year, normally.

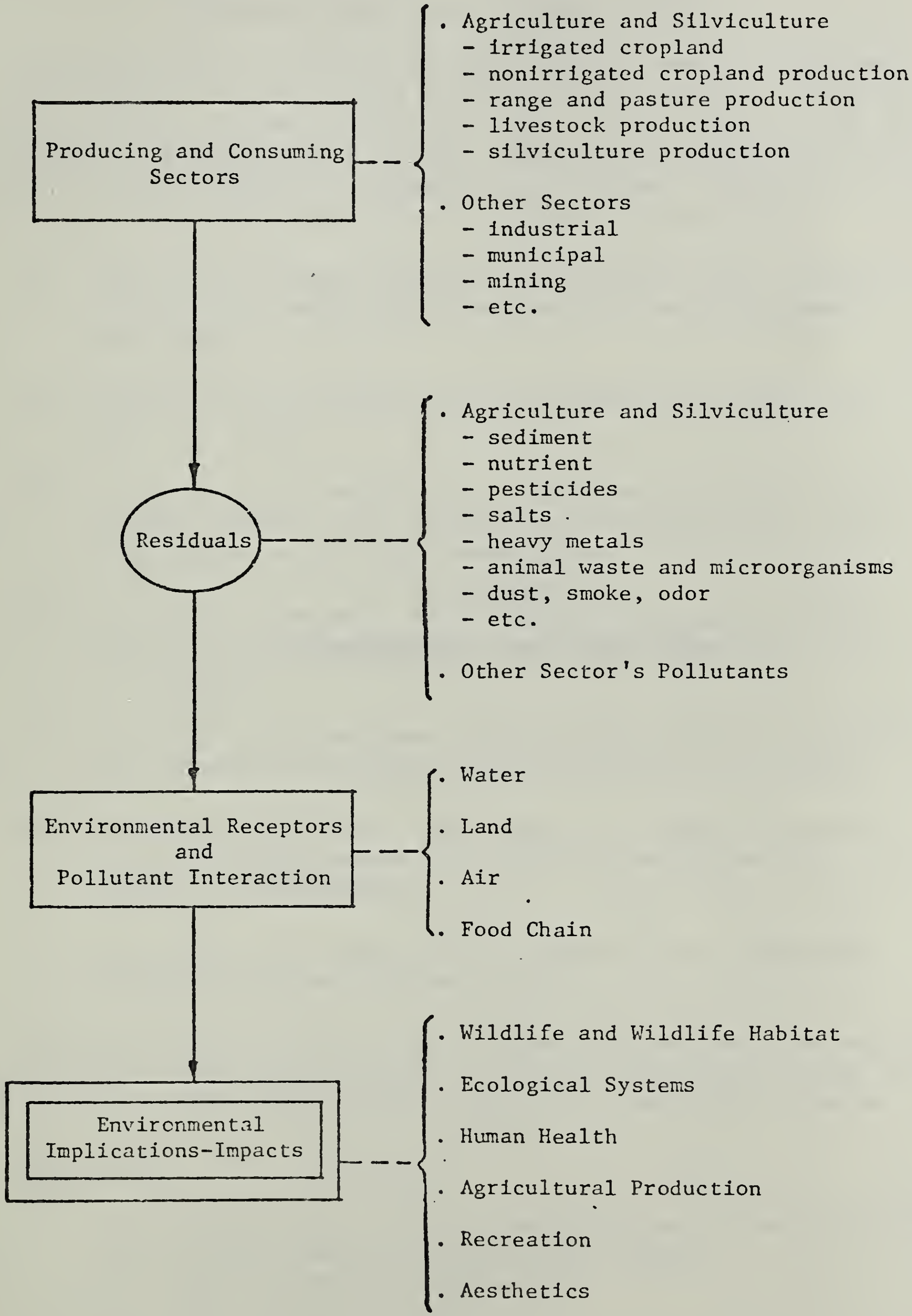
POULTRY LAYER AND BROILER MANURE CONTENT AND MANAGEMENT SYSTEMS

MANAGEMENT SYSTEM	Estimated nitrogen loss (percent)	Percent final moisture	Shrink ratio	Incorporated nitrogen pounds per ton	Mineralization coefficient [1,2]	Nutrients available first year pounds per ton N	P_2O_5	K_2O
1. Fresh layer manure, collected and applied daily, incorporated before drying.	5	75	1:1	30	.9	27	22	16
2. Layer manure stored in shallow pit, cleaned every 3 months, incorporated before drying.	30	65	1.5:1	34	.75	25	27	24
3. Layer manure stored in fan ventilated deep pit, cleaned yearly and incorporated - cool, humid climate.	55	50	2:1	30	.75	23	52	45
4. Broiler manure on sawdust or shavings litter, cleaned every 4 months and incorporated - warm, humid climate.	50	25	3:1	48	.75	36	33	41

[1] Phosphorus, in general, is combined in the same organic compounds as is the organic nitrogen. Mineralization of P will be about the same as mineralization of N.

[2] Potassium is found in the liquid portion of the waste and all of it is available the first year, normally.

A FLOW DIAGRAM OF SOURCES OF ENVIRONMENTAL POLLUTION
AND THEIR IMPLICATIONS



Source EPA. <u>Environmental Implications of Trends in Agriculture and Silviculture</u>

Volume 1: Trend Identification and Evaluation, 1977

APPENDIX G

UNIVERSAL SOIL LOSS EQUATION

Universal Soil Loss Equation (USLE)

The Universal Soil Loss Equation (USLE) computes long-term average annual soil losses for specific combinations of land conditions and use. It was developed about 20 years ago by the U.S. Department of Agriculture's Science and Education Administration-Federal Research (SEA-FR) (formerly Agricultural Research Service), and was designed and field tested for the following uses:

1) Predicting average annual soil movement from a given field slope under specified land use and management conditions.

2) Guiding the selection of conservation practices for specific sites.

3) Estimating the reduction in soil loss attainable from various changes that a farmer might make in his cropping system or cultural practices.

4) Determining how much more intensively a given field could be safely cropped if contoured, terraced, or stripcropped.

5) Determining the maximum slope length on which cropping and management systems can be tolerated in a field.

6) Providing local soil loss data to use when discussing erosion control needs and conservation plans with farmers or contractors.

7) Estimating soil losses from construction, rangeland, woodland, and recreational areas.

The prediction accuracy of the equation has been checked and found to be statistically reliable provided the equation has been used properly. The USLE predicts <u>only</u> sheet and rill erosion.

The equation is: $A = RKLSCP$

A = Average soil loss in tons per acre per unit of time
R = Rainfall and runoff-erosivity factor
K = Soil-erodibility factor
L = Slope-length factor
S = Slope-gradient factor
C = Cropping-management factor
P = Erosion-control practice factor

The following is a brief description of each factor and how it was determined and used for the SNAP appraisal.

R - Rainfall and runoff-erosivity factor - is a measure of the erosive forces of rainfall and runoff. The energy of moving water detaches and transports soil particles. The energy-intensity (EI) parameter is the product of two rainstorm characteristics: total kinetic energy of a storm times the maximum 30-minute intensity. The product reflects the combined potential of raindrop impact and turbulence of runoff to transport dislodged soil particles. Soil losses are linearly proportional to the number of EI units. EI values from all storms within a year are added to obtain an annual rainfall and runoff-erosivity factor (R) for a given location. This factor has been evaluated for many years and the values are reliable long-term regional averages. In this study an R value of 100 was used in all counties except Aroostook, which used 75.

K - Soil-erodibility factor - reflects the inherent erodibility of a particular soil. When rainfall with a known erosive potential falls on a standard research plot (soil in cultivated continuous fallow, on a 9 percent slope 72.6 feet long) of a known soil type, the eroded soil leaving the plot indicates the erodibility of that soil. The capability of a soil surface to resist erosion is a function of the soil's physical and chemical properties, such as texture, organic matter content, soil structure, permeability, and surface stoniness. K can be computed as a function of these properties or developed experimentally through research. Values of K used in the SNAP appraisal ranged from 0.17 to 0.49 depending on the soil series. Soil types were determined from published, interim, or unpublished soil surveys. K values were taken from the SCS Field Office Technical Guide.

L - Slope-length factor and S - Slope-gradient factor - are dimensionless factors that adjust the soil loss estimate for effects of length, steepness, and shape of the field slope. They are combined because of their close interaction. The LS factor is the expected ratio of soil loss per unit area on a field slope to corresponding loss from the standard research plot. Doubling the length of slope increases erosion approximately 1.5 times. Doubling the steepness (percent slope) increases erosion approximately 2.5 times. Slope length is the distance from the point of origin of overland flow to the point where the slope gradient decreases enough to cause deposition or to a point where runoff enters a well defined channel. In this appraisal the average slope gradient for a field was measured with an Abney level and average length of slope was measured on aerial photographs.

<u>C - Cropping-management factor</u> - introduces the effects of the cropping system and management variables on soil loss. The basic soil loss is the rate at which a field would erode if it were continuously in tilled fallow. The equation's factor C indicates the percentage of this potential soil loss that would occur if the surface were partially protected by some particular combination of cover and management.

During the erosion study, judgment was needed to select the correct C value. An estimate had to be made as to what rotation was being used on each farm unit. This was often done in relation to the percentage of a farm unit that was in potatoes and other crops. For example, if one quarter of the farmland was in oats, one quarter in hay, and the remainder in potatoes, the rotation would be estimated as potatoes, potatoes, oats, and hay. Unless otherwise known, all potatoes were considered to be fall plowed, late harvested, with residue left.

<u>P - Erosion-control practice factor</u> - reflects the benefits of supporting practices, such as contouring, contour stripcropping, cross-slope farming, and cross-slope farming with strips. Terraces or diversions are not included because they reduce the length of slope only. P is the ratio of soil loss with the supporting practice to the soil loss with up and down hill cultivation. For example, contour stripcropping on gentle slopes can reduce soil loss by 75 percent. The value of any practice is reduced as slopes steepen.

Soil erosion by water is influenced by many variables. The soil loss equation isolates significant variables and expresses them as a number. When the numbers for all six variables are multiplied, the product is the amount of soil loss expressed in tons per acre per year. Soil loss was not predicted for a specific year, but rather for long-term average annual loss under specific conditions. The USLE does not estimate gully erosion.

The following example illustrates the use of the USLE:

A 20-acre field on Caribou gravelly loam is evaluated for soil loss. The average slope is 700 feet long and has a gradient of 6 percent. The rotation is 3 years of potatoes followed by 1 year of grain (PPPG). The R factor for this area is 75. The combined LS factor is 1.78. Caribou soils have a K factor of .28. Potato vines are left after a late harvest and the field is fall plowed resulting in an average C factor for the PPPG rotation of .31. The field is farmed cross slope; therefore, the P factor is .75. Average soil loss (A) = RKLSCP, A = 75 X .28 X 1.78 X .31 X .75 or 8.7 tons per acre per year. Since it is a 20-acre field, total average annual soil loss from sheet and rill erosion is 174 tons per year.

APPENDIX H

LIVESTOCK AND EROSION MAPS

Copies of Livestock and Erosion Maps are available from Soil and Water Conservation Districts (addresses on pages 71 and 72). A limited number of complete sets of maps (100 maps per set) covering the agricultural areas of Maine are available from Warwick M. Tinsley, Jr., State Conservationist, USDA Soil Conservation Service, USDA Building, University of Maine, Orono, Maine 04473.

REFERENCES

Agricultural Research Service. 1975-1976. Control of Water Pollution from Cropland. Volumes I and II. Reports No. ARS-H-5-1 and 2. U.S. Department of Agriculture. Hyattsville, Md.

Agway Chemical Control Guide. 1977.

Borns, H. W., Jr., John Dimond, and Steve Norton. 1971. Report on Groundwater Quality in and Near Cherryfield, Maine. Unpublished University of Maine at Orono Report to Maine State Planning Office.

Bouldin, D. R., and G. W. Selleck. Management of Fertilizer Nitrogen for Potatoes Consistent with Optimum Profit and Maintenance of Groundwater Quality. Paper No. 707. College of Agriculture and Life Sciences. Cornell University, Ithaca, N.Y.

Bourque, Peter. 1976. The Effects of Cropland Erosion on Fishery Resources.

Cobbossee Watershed District. 1977. Non-Point Sources of Pollution to Lakes.

Dornbush, J. N., J. R. Andersen, and Leland L. Harms. 1974. Quantification of Pollutants in Agricultural Runoff. U. S. Environmental Protection Agency, Washington, D.C.

Life Sciences and Agriculture Experiment Station and the Maine Soil and Water Conservation Commission. 1972. Maine Guidelines for Manure and Manure Sludge Disposal on Land. Miscellaneous Report 142. University of Maine, Orono.

McElroy, A. D., S. Y. Chiu, J. W. Nebgen, A. Aleti, and F. W. Bennett. 1976. Loading Functions for Assessment of Water Pollution from Non-Point Sources. U.S. Environmental Protection Agency. National Technical Information Service, Springfield, Va.

Meisinger, John J. 1976. Nitrogen Application Rates Consistent with Environmental Constraints for Potatoes on Long Island. Search - Agriculture 6 (7) Cornell University, Ithaca, N.Y.

Northern Maine Regional Planning Commission and E. C. Jordan Co. 1976. St. John River Basin Water Quality Plan.

Rourke, Robert V. Project NE-39 Northeast Regional Soil Nitrogen Technical Committee. Annual Reports 1973-1977.

Rourke, Robert V., Hugh J. Murphy, and Ernest N. Richardson. Disposal of Pesticide Containers. Progress Reports 1975-1977.

Stanford, G., C. B. England, and A. W. Taylor. 1970. Fertilizer Use and Water Quality. Agricultural Research Service, ARS 41-168.

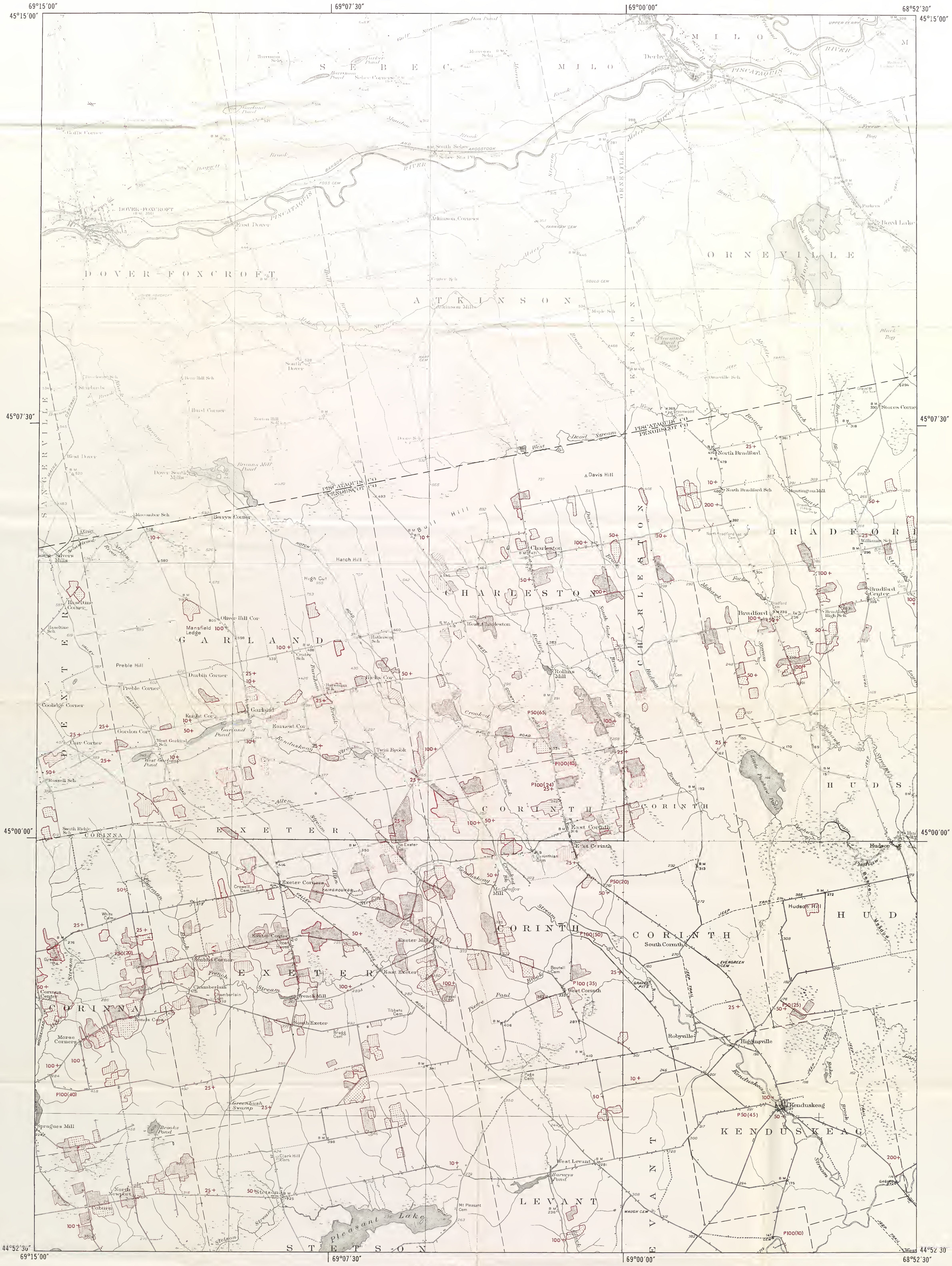
Stoddard, Carlton D. 1977. Tons O' Gold.

USDA Soil Conservation Service. 1977. Agricultural Waste Management Field Manual.

U.S. Environmental Protection Agency. 1977. Environmental Implications of Trends in Agriculture and Silviculture. Vol. 1.

U.S. Environmental Protection Agency. 1973. Methods for Identifying and Evaluating the Nature and Extent of Non-Point Sources of Pollution.

Working Group on Pesticides. 1970. Summary of Interim Guidelines for Disposal of Surplus or Waste Pesticides and Pesticide Containers. National Technical Information Service, Springfield, Va.



SOURCE of Base Map: U.S. Geological Survey 15′ and 7½′ quadrangle maps (provided by Soil and Water Conservation Districts and the State Planning Office).

MAINE

SPONSORED by the Maine Soil and Water Conservation Commission and the Maine Department of Environmental Protection and the Maine State Planning Office in cooperation with the USDA Soil Conservation Service and the Statewide USDA 208 Committee.

LEGEND

ANIMAL UNITS, NON – POULTRY FARMS

10+	10-24	Animal Units
25+	25-49	Animal Units
50+	50-99	Animal Units
100+	100-199	Animal Units
200+	200-399	Animal Units
400+	400-599	Animal Units
600+	600-799	Animal Units
800+	800-999	Animal Units
1000+	1000-1099	Animal Units
1100+, 1200+		Animal Units On Larger Farms

AVERAGE ANNUAL SOIL LOSS (tons/acre/year)

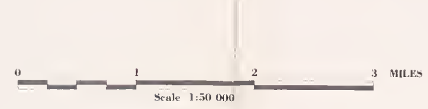
0-3 tons
4-5 tons
6-7 tons
8-10 tons
11-25 tons
26+ tons
Gully

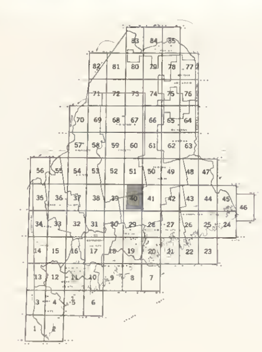
ANIMAL UNITS, POULTRY FARMS

P10	10-24	Animal Units
P25	25-49	Animal Units
P50	50-99	Animal Units
P100	100-199	Animal Units
P200	200-399	Animal Units
P400	400-599	Animal Units
P600	600-799	Animal Units
P800	800-999	Animal Units
P1000	1000-1099	Animal Units
P1100, P1200		Animal Units On Larger Farms

( ) Number Of Acres Available For Waste Disposal

△ APPROVED ANIMAL WASTE FACILITY





PENOBSCOT COUNTY
SOIL AND WATER CONSERVATION DISTRICT